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FINAL REPORT
MASSACHUSETTS WOOD RECOVERY PROJECT
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Cooperators:

The Forest and Wood Products Institute
The Mass. Department of Environmental Management, Division of Forests and Parks
The USDA Forest Service, Northeastern Area State and Private Forestry
The Mass. Department of Food and Agriculture
Hubbard Forest Industries
Roberts Brothers Lumber
The Drawing Office
Sargent's Wood Products

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Dedication

John Tierney, principle of The Drawing Office, and a valued member of our project team, passed away unexpectedly on October 22, 2001. John contributed hard work, imagination, and creativity to our project. His greatest contribution, however, was his constant optimism and his faith in our efforts. His loss is deeply felt by those who worked closely with him. We would like to dedicate this report to his memory.

Acknowledgements

We would like to thank the many people and businesses that contributed time, products, and ideas to the project. Chief among them would be Walt Hubbard and his staff at Hubbard Forest Industries. We would also like to thank the Massachusetts Department of Food and Agriculture, which provided financial support for the project through the Agro-Environmental Technology Program, and the U. S. Dept. of Agriculture Forest Service, which also provided financial support through the Economic Action Program.

The Mass. Wood Recovery Project Committee

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TABLE OF CONTENTS

THE APPENDIX ARE NOT INCLUDED IN THIS COPY OF THE REPORT. PLEASE CONTACT THE Forest and Wood Products Institute FOR COPIES.

<u>APPENDIX</u>

I. Introduction

A. Background

In May and July of 2000 the Forest and Wood Products Institute was awarded grants from the Mass. Department of Agriculture and the US Forest Service, respectively. These grants were for the purpose of demonstrating the feasibility of manufacturing marketable wood pieces or panels from sawmill wastes and small logs.

The Massachusetts Wood Recovery Project had its beginnings in 1998 when the owner of a local sawmill brought some large wood slabs into a meeting of the Forest and Wood Products Institute's Advisory Board. The slabs contained a good amount of clear and potentially valuable wood. However, because the slabs were not long enough to produce the minimum sized board specified in the hardwood lumber grading rules, they were destined for the chipper. The end result was that potentially high valued wood was manufactured into a low valued product, and one for which the markets are at times uncertain.

As a follow-up to this discussion, the mill owner and the Director of the Institute visited a local furniture manufacturer with the slabs. The furniture company said that they would gladly purchase such wood, but it would have to be first manufactured into the dimensions that they could use. Unfortunately, the mill owner had neither the equipment, nor the quantities of product that would be needed. He requested the assistance of the Institute to explore the possibility of creating a business that could provide these parts for local wood-users, utilizing low-valued material.

The Institute commissioned a study that was performed by The Drawing Office of Northampton, Massachusetts. Their Preliminary Feasibility Report examined the feasibility of building an experimental sawmill dedicated to deriving products from under-utilized species and low-valued logs. The report concluded that it was possible to profitably produce wood products from non-traditional, low-value, source material. Some potential products and markets were suggested.

This current study was designed to follow up on some of the issues and ideas raised in the initial report. Its purpose is to: examine the availability of under-utilized and low-valued raw materials; examine processes and strategies for manufacturing products from these materials; identify potential markets for these products; study the feasibility of producing these parts through the actual production of products; and to propose a model business plan based upon the production of these products.

Massachusetts has a healthy and abundant forest resource that is greatly underutilized. Only eleven percent of the forest products consumed in Massachusetts annually are locally grown and harvested. Only 55% of the wood fiber (in growing stock trees greater than 5 in. DBH) grown on our forests each year is harvested. Increasing the utilization of this resource through the creation of new wood-based businesses, or through the improvement of existing businesses, would improve the forester's ability to perform silvicultural operations on young forest stands and would also benefit the economies of our rural communities. The majority of our forestland is located in and around some of the poorest communities in the state. Wood products companies have historically played an important role in the economies of these towns.

Our forest products industry is, however, a mature industry that is facing changing technologies, changing markets, and a changing resource. Most Massachusetts sawmills are grade mills. That is, they are designed to produce grade hardwood and softwood lumber from saw logs (usually trees >12"diameter). Healthy markets, therefore, exist for the "big game" species in the forest, the high quality large sawlogs of merchantable species (primarily, but not limited to, white pine, northern red oak, white oak, white ash, black cherry, and yellow birch). The state's forests have readily produced these logs in sufficient numbers, but the composition of the forest, and the nature of the wood marketplace, is changing.

Good sawlogs are becoming harder to find because of past harvesting practices and decreases in the amount of commercial forestland. Lesser quality species constitute a larger percentage of the forest's growing stock. Red maple, a generally low-valued species, is now the most common tree in the forest.

Eastern Hemlock, also poorly utilized, is the fourth most common species. The percentages of these and other underutilized species will continue to grow if current trends continue.

The state's forestlands are capable of producing a continuous supply of quality sawlogs if proper silvicultural practices are applied. This requires, however, that poorer quality trees be removed during thinnings and harvests to allow sufficient room for the more desirable trees to regenerate and grow. The lack of markets for these poorer quality trees, though, has impeded the forester's ability to carry out these practices, and endangered the future composition of the forest.

Sawmills have little trouble selling "grade" lumber, but the grade yield will decline as the resource changes, and the markets for poorer grade lumber are not good. The recent rise in local stumpage prices, coupled with steady lumber prices, has put the squeeze on local mills, increasing their need to optimize yields (minimizing waste), and to add value to low-grade lumber and sawmill residues. Traditional practices of cutting to meet industry lumber grade rules will not necessarily meet these needs.

There are a large number of secondary wood product manufacturers operating within our target area that utilize the types of wood grown in the state, but very few sawmills sell directly to these markets. These secondary manufacturers purchase their wood in the form of either lumber or component parts. It is possible that local mills could produce value-added component parts and sell directly to these markets, but the connections currently do not exist and there is a need for more knowledge on the extent and character of these markets.

Many secondary manufacturers conduct the primary breakdown of lumber in-house, but this practice is changing. If a company purchases finished parts instead of lumber they can reduce their overhead and capital costs, free up valuable manpower for other parts of their operation, improve product quality, and rid themselves of the burden of dealing with excessive volumes of wood waste. The potential exists, therefore, for primary lumber manufacturers to provide clear wood parts and panels for the secondary industry. If these products can be manufactured from low-valued lumber and logs these manufacturers could also increase their profits, improve their yields, and reduce their inventories. At the same time we would create the potential for improved forest management by creating new markets for low-valued and under-utilized forest products.

B. Project Goals

The Massachusetts Wood Recovery Project is an attempt to address these problems and concerns by investigating the potential for producing value-added wood component parts from low-valued or under-utilized species. Through this process we will be able to gather information on the raw material supply, the potential market, and costs and yields associated with value-added processing.

The Wood Recovery Project Committee set the following goals for this project:

Goal 1: Extract high-valued wood from low valued logs and lumber

Objectives:
- a. Determine availability of low-grade lumber from local producers
- b. Develop a transportation system for collecting materials
- c. Research machines and systems
- d. Obtain needed machinery and shop location for production of prototype
- e. Produce prototype pieces and panels
- f. Track costs and yields

Goal 2: Create market links between local producers and regional wholesale and retail buyers. Create demand, and a market, for several new products.

Objectives:
- a. Produce prototype pieces and panels
- b. Develop a marketing strategy

c. Have furniture makers produce prototype pieces using our panels
d. Identify and attend trade shows to promote our products.
e. Identify demand: quantities, species, dimensions
f. Research similar projects and businesses

During this project we plan to:

(1) Quantify the volume and value of low grade logs, lumber and recoverable waste stream materials (#2 Common or industrial grade lumber, short lumber, odd lots, slabs, trimmings, and edgings) being produced by local mills and forests.

(2) Quantify the wood needs of the local secondary wood industry and identify specific markets for specific products that could be produced from our raw materials supply.

(3) Develop a business and marketing plan, including processes for collecting raw materials and manufacturing them into a high value product such as: furniture dimension stock, hardwood and softwood panels, flooring, window and door sash, and other paint-grade finish carpentry residential components.

(4) Demonstrate the production of clear pieces and begin test marketing of value-added wood products.

(5) Present our findings to the local wood industry and other interested parties.

We are going to try to change the focus from large, long, and clear lumber and logs to small furniture size pieces (dimension stock), that can be processed from low value short and small stock, and are much higher in value after processing. We are going to create high value pieces from low value stock. This raises the value of material that would otherwise be left in the forest to rot or sent to the chippers to create more waste products.

The potential added value of this process is significant. For instance, one thousand board feet of red oak will be worth only $26 if converted into chips. Manufactured into furniture dimension parts or panels they would be worth $2,000 to $2,800. White pine would increase in value from $15 to $1,000 to $1,500.

The methods for cutting, drying, and machining small pieces have been a topic of research for the Forest Service for many decades. Several mills are in operation in the Midwest that produce these parts from their residues and low-valued products. We plan to learn from their operations by visiting these sites, and planning our processing procedures based on their experience. Learning mechanical processing from experienced people goes a long way toward establishing efficient work flows. These efficiencies are absolutely necessary in order to produce products at affordable and reasonable prices. The goal overall is to make economically successful products that form the economic engine for better harvesting practices that in turn contribute to the improvement of forest health and productivity.

These products could become more than a means for capturing value from species, logs, and lumber of low value. They could also serve to tell the public the story of the Massachusetts woods, creating a pathway for the industry to reach the general public with their story, and increasing the public's understanding of sustainable forestry practices through the marketplace.

II. Methods and Procedures

A. Quantify the volume and value of low-grade logs, lumber and recoverable waste stream materials being produced by local mills and forests.

There are three potential sources for raw materials for this process: the forest (logs and tops); the sawmill (slabs, edgings, trimmings, low-grade, mis-sized lumber, and odd lots of lumber); and, the urban/suburban forest (street and shade trees and recycled pallets).

- Data on the forest resource was obtained primarily from the US Forest Service 1998 Forest Inventory Analysis.
- Data on sawmills was obtained through the 1997 Directory of Mass. Sawmills, and a survey of all local mills producing 500,000 board feet or more per year, conducted as a part of this study.
- Data on the urban forest was obtained from previous studies conducted by the Forest and Wood Products Institute.
- Supporting data and information was also obtained through a review of the existing literature.

B. Quantify the wood needs of the local secondary wood industry and identify specific markets for specific products that could be produced from our raw materials supply.

- A database of almost four hundred wood-using companies operating within seventy miles of Gardner, MA, was developed from membership lists, directories, and phone books.
- A phone survey of all companies on this database was conducted to determine their wood needs and preferences.
- Members of our committee visited several wood-using businesses to observe their practices.
- Orders were solicited from a subset of the companies on our database for wood parts, panels, and turning squares.

C. Develop a business and marketing plan, including processes for collecting raw materials and manufacturing them into high value products.

- Relevant information was obtained through a literature search, interviews, and visits to companies that have undertaken value-added processes.
- Consultants were hired to develop the plan.

D. Demonstrate the production of clear pieces and begin test marketing of value-added wood products.

- Orders to be filled were chosen from the orders received based upon their compatibility with our source material.
- Logs were obtained from Mass. Metropolitan District Commission (MDC) forestland and milled at Hubbard Forest Industries.

- Pallet lumber was obtained from Hubbard Forest Industries of Royalston, MA. This lumber was dried, along with the lumber milled from the logs, in Hubbard's kilns.

- Contracts were developed with local wood shops for the actual production of parts, panels, flooring, and turning squares. Sargent Wood Products of Gardner, MA, provided the bulk of the production. Also assisting were Eustis Chair of South Ashburnham, MA, and Forester Moulding of Leominster, MA.

- Completed products were delivered to the end users. These companies completed a follow-up questionnaire and were interviewed by project consultants.

E. Present our findings to the local wood industry and other interested parties.

- A bibliography of the literature utilized in the project will be prepared and made available to interested parties.

- The database of wood-using businesses will be made available to interested parties.

- This project report, with the business plan, will be made available to interested parties.

- If feasible, a seminar will be held at the conclusion of the project to disseminate our findings. All members of the local industry will be invited.

III. Supporting Information and Data

A. Raw Material Supply

1. Availability of small and low grade logs from the forest

This project seeks to create new local markets for presently under-utilized or low-valued forest products. These can be defined as both small merchantable trees (8 to 12" DBH), low quality sawlogs (Forest Service Log Grade 3 or worse), and logs of under-utilized species (most notably red maple, beech, and eastern hemlock).

According to the 1998 Forest Inventory Analysis for Massachusetts there is an abundant supply of trees on our forestland that fit into these categories. Tables 1 and 2 provide relevant inventory data for ten common species. Red maple, white pine, red oak, and hemlock are the four most common species growing in Massachusetts. Sugar maple, yellow birch, white ash, and black cherry are listed because they are the most common species used in local furniture production. Black birch and beech are included as two relatively underutilized species.

Table 1. Forest Inventory Analysis Data for Ten Common Species. (In thousands of board feet.) Source: *Forest Statistics for Massachusetts, 1985 and 1998*, Tables 37 and 41.

Species	Net Volume, Sawlogs	Average Annual Growth	Average Annual Removals	Annual Net Change	Percent of Growth Harvested
White Pine	5,602,800	111,310	43,469	67,841	39%
Red Maple	2,110,100	43,978	6,731	37,247	15%
N. Red Oak	1,946,100	47,750	27,541	20,209	58%
E. Hemlock	1,792,400	46,862	3,147	43,715	7%
Sugar Maple	603,800	4,824	1,224	3,600	25%
Black Cherry	566,600	19,454	427	19,027	2%

White Ash	534,100	16,055	2,514	13,541	16%
Beech	365,000	5,057	775	4,282	15%
Black Birch	363,700	12,367	1,609	10,758	13%
Yellow Birch	212,600	5,133	13,865	(8,732)	270%

The net board foot volume of sawlogs for all species growing on timberland in Massachusetts is 16.5 billion board feet. This averages to 6.3 thousand board feet per acre (2,631,100 acres of timberland). Hardwoods account for 52.7% of this volume, softwoods, 47.3%. White pine alone accounts for 34% of the total volume, and the four major species, w. pine, r. maple, r. oak, and hemlock, account for 69% of the total volume (11,451,400,000 board feet).

The average annual net growth (1984 through 1997) for all species on timberland is 388,426,000 board feet. Hardwoods account for 55.7% of this net growth. White pine alone accounts for 28% of the annual net growth. The average annual harvest of sawlogs is 132,311,000 board feet. Sixty percent of the harvest is hardwood sawtimber. With the exception of yellow birch, northern red oak, white pine, and sugar maple, we are harvesting 16% or less of the annual net growth of all the other species listed.

Table 2. Volume of selected species by Forest Service tree grade (millions of board feet). Source: *Forest Statistics for Massachusetts, 1985 and 1998*, Table 38.

Species	Net Volume, Sawlogs	Tree Grade 1	Tree Grade 2	Tree Grade 3	Tree Grade 4	Tree Grade 5	Volume in Grades 3 - 5	% of net volume in grades 3-5
White Pine	5,602.8	166.6	1,261.4	2,246.5	1,078.9	849.4	4,174.8	75%
Red Maple	2,110.1	92.5	421.8	1,058.2	148.0	389.6	1,595.8	75%
N. Red Oak	1,946.1	370.4	645.9	726.7	15.9	187.3	929.9	48%
E. Hemlock	1,792.4	1,195.1	-	-	-	597.3	597.3	N/A
Sugar Maple	603.8	81.2	137.2	271.4	34.1	80.0	385.5	64%
Black Cherry	566.6	126.7	140.9	193.5	27.6	77.9	299.0	53%
White Ash	534.1	148.6	135.7	198.0	3.4	48.4	249.8	47%
Beech	365.0	11.8	54.4	172.5	62.0	64.3	298.8	82%
Black Birch	363.7	20.1	92.8	218.8	21.2	10.7	250.7	69%
Yellow Birch	212.6	4.5	45.3	109.2	3.8	49.8	162.8	77%

The Forest Service tree grades are described in Appendix A. Hemlock trees are not graded. Hardwood tree grades are based upon the characteristics of the butt log, to a height of sixteen feet. Grade one and two trees have a larger diameter, and are generally more free of visible defects (grade is based upon clear cuttings in the third best face). These are the higher quality logs, capable of producing quantities of grade lumber. Grade three trees have a minimum DBH of 11 inches, and can be up to 50% defective. Grade 4 hardwoods are tie and timber grades, and grade 5 are merchantable trees that didn't qualify for a higher grade.

White pine grades one through four require a minimum DBH of 9 inches. The maximum scaling deduction from the butt log is 50% for grades one to three, and unlimited for grade 4. A grade one tree will have two full clear faces in the 16 ft. butt log (or four clear half-faces). Grade two trees are limited to red knots that do not exceed 1/6 of the scaling diameter (3 in. maximum), and black knots that don't exceed 1/12 of the scaling diameter (1.5 in. maximum). Grade three trees can have red knots that do not exceed 1/3 of the scaling diameter (5 in. maximum), and black knots that do not exceed 1/6 of the scaling diameter (2.5 in. maximum). Grade four trees do not meet these specifications, but they have at least 1/3 of their gross volume in sound wood suitable for manufacture into standard lumber. Grade 5 is merchantable trees that didn't qualify for a higher grade.

Trees in grades one and two are basically the higher valued trees suitable for producing high percentages of grade lumber. A healthy market exists for these trees. No data exists to indicate what percentages of the trees that are harvested are within these grades, but we can assume that they constitute the highest percentage of trees harvested. Trees of grade three and below would, by definition, be the low quality, and under-utilized trees with which we are concerned. As discussed below, grade three trees would still be capable of producing clear pieces through the process we are proposing, so they would therefore be the targets of our interest. As indicated by Table 2 there is an abundant amount of trees in the grade three category. Forty-five percent of all hardwoods (3.9 billion board feet) and forty percent of white pine trees (2.2 billion board feet) fall into grade three.

Table 3. Net volume of growing stock on timberland by diameter class for selected species (millions of cubic feet). Source: *Forest Statistics for Massachusetts, 1985 and 1998*, Table 33.

Species	Dia. Class 7.0 - 8.9	Dia. Class 9.0 - 10.9
White Pine	88.6	122.0
Red Maple	208.4	187.7
N. Red Oak	76.3	120.5
E. Hemlock	55.7	65.7
Sugar Maple	43.3	30.1
Black Cherry	20.4	34.9
White Ash	17.8	28.6
Beech	15.0	10.9
Black Birch	29.3	24.8
Yellow Birch	28.9	17.2

Table 3 shows volumes for growing stock trees between seven and eleven inches DBH. Growing stock trees are live trees of commercial species excluding rough and rotten trees. Growing stock volume is calculated to a four-inch top diameter outside the bark. The Forest Service did not calculate board foot volumes in these size classes because they were under the minimum diameter for sawlogs. For sawlogs, board foot volume is calculated to a six-inch top for softwoods, and an 8-inch top for hardwoods (diameter inside the bark). Theoretically there are twelve board feet in a cubic foot of wood. However, saw kerf, slabs, trimmings and edgings are not accounted for in the cubic foot measurement, and all reduce the volume of recoverable board feet. Lumber Recovery Factor (LRF) is a standard measurement of sawmill efficiency that relates cubic feet of logs to board feet of lumber recovered (bd. ft. lumber/cu. ft. logs). The LRF can range from 4 to 10, depending on sawmill equipment and efficiency, and log size and taper. The volume in these diameter classes for the species in Table 3 adds up to 1,226.1 billion cubic feet. Using a conservative LRF of 4, this is comparable to 4.9 billion board feet of small diameter logs.

For the reasons stated above, this is only a rough estimate of the volume available in small diameter trees. It is also unknown what percentage of this volume is available for harvest. Included within these classes are future crop trees that should be grown to a larger diameter before harvest. If we assume, however, that only as low as one percent of this volume is available in lower quality trees that should be thinned to release crop trees, that still amounts to almost 50 million board feet in 7.0 to 10.9 in. DBH trees (for these ten species).

In summary, the forest survey data shows that the Massachusetts forest contains an abundance of low quality and under-utilized species and stems. Red maple in particular is available in abundance. This species accounts for 24% of all live trees, 5 inches DBH and greater, 18% of all growing stock volume, and it is growing at a rate 2.5 times faster than it is being removed (relative to growing stock volume. It is growing 6.5 times the sawtimber volume than is being removed). Seventy-five percent of red maple volume is in tree grades 3 or lower.

Hemlock (11.8 to 1) and beech (13.8 to 1) are two other species that are growing far faster than they are being harvested. Northern red oak and eastern white pine also merit attention. They are ranked third and first, respectively in total net volume. Although they are being harvested at higher rates than these other species, their growth still exceeds their harvest, and a large percentage of the standing trees of these species are rated as tree grade three or below (78% for white pine, 48% for red oak).

2. Availability of raw materials from local sawmills

In order to estimate the volume and character of raw materials available from local sawmills we conducted a survey, and also visited some local mills. Five Massachusetts sawmills were visited in the summer of 2000 in order to assess the availability of low valued/waste stream material. A follow-up survey was sent to these and 37 other mills in the region to collect data.

a. Sawmill Survey

Forty-one Massachusetts sawmills and one New Hampshire mill (Beaman Lumber Co.) were mailed a survey in August, 2000. A copy of the survey and survey results is included in Appendix B. The Massachusetts mills were all of those who reported an annual production of 500,000 board feet or more in the 1997 Directory of Sawmills, Dry Kilns, and Lumber Treaters in Massachusetts, published by the Massachusetts Department of Environmental Management, Bureau of Forestry. These mills produce 94% of the lumber manufactured in Massachusetts, based upon the data provided in the directory. Follow-up phone calls were made in October, and a second mailing was done in November to all that had not responded.

In all, 19 completed surveys were returned, representing 45% of the surveys mailed. These mills reported an annual production of 42.2 million board feet, 40% of the state's annual production. The average annual production of the responding mills was 2.22 million board feet.

White pine lumber, at 15.6 million feet, accounted for 37% of the total production, but hardwood production was greater than softwood, 23.5 million (56%) to 18.6 million feet (43%), respectively. Red Oak was the next most common wood at 9.6 million feet (23%). No other single species accounted for more than 6% (other hardwoods did account for 12% of total production).

The nineteen responding mills produce an estimated 43,000 tons of wood chips annually. The average rate of chip production was 1.21 tons per thousand board feet of lumber. There was, however, quite a range, as this figure varied from a low of 0.24 to a high of 2.6 tons per MBF.

In comparison, Sarah Smith, Forest Industry Specialist for the University of New Hampshire Cooperative Extension, reports that a study of fifteen New Hampshire sawmills showed that pine mills with band headrig and multiple band resaws produced 1 ton of chips per thousand board feet of lumber, pine mills with circular headrigs and bull edgers averaged 1.58 tons/MBF, and hardwood band mills with single band resaws averaged 1.03 tons/MBF. Sloane Crawford, New York State Forest Products Utilization and Marketing Forester, estimates that chips from slabs and edgings amount to 23% of log weight for band mills, and 22% for circular mills. For hardwood logs weighing 5.3 tons (green) per MBF (Int'l 1/4 inch rule), this converts to 1.22 tons/MBF for a band mill and 1.17 tons/MBF for a circular saw.

Reported annual production of pallet lumber and cants was 15.5 million feet, or 37% of the total production. Almost half (49.8%) of the hardwood lumber produced was in pallet lumber or cants, compared to only 20% of the softwood lumber produced. Table 4 provides a summary of the pallet data. Many respondents reported 'hardwood', or 'softwood' production, but did not break those totals down into individual species, so there is no reliable data on specific species.

Table 4. Pallet lumber and pallet cant production by responding mills.

Species Group	Total Production (MBF)	Pallet Lumber Produced (MBF)	%	Pallet Cants Produced (MBF)	%	% of Total in Pallet Lumber or Cants

All Hardwoods	23,513.6	7,427	31.6	4,275	18.2	49.8
All Softwoods	18,628.4	2,442	13.1	1,331	7.1	20.2

Other potential sources of raw materials from the sawmill includes industrial grade white pine lumber, odd lots (unsold excess production), and under-sized lumber. Our respondents reported an annual production of 4,255 MBF of industrial grade white pine lumber. This is approximately 27 percent of the total white pine production.

The current inventory of odd-lots or undersized lumber is always changing. The survey responses can only provide a snapshot of one point in time. Only three mills reported inventories of odd lots. One mill reported 8MBF total in this category, another, 57 MBF, and a third, 198 MBF. Products included red oak, red oak select KD, hemlock, and white pine, furniture grade KD, in lots from 3 to 140 MBF. Four mills reported inventories of undersized lumber ranging from 2 to 50 MBF.

b. Sawmill Visits

Five Massachusetts sawmills were visited for the purpose of observing and assessing the production and flow of waste materials and to evaluate the suitability of other sawmill products for the production of dimension parts or panels.

The production of the mills visited ranged from two to seven million board feet per year. All of them milled a variety of species. Even those that specialized in hardwoods still had about ten percent of their production in softwoods. Red oak was the primary hardwood species being milled, but each of the mills was handling six to ten other hardwood species in varying amounts (red maple, cherry, sugar maple, ash, paper birch, yellow birch, black birch, white ash, white oak, and other oaks).

Two of the five mills have dry kilns. Four of the five mills have circular headsaws. Three of the five have band re-saws. Another had a scragg mill with an edger-optimizer. Only one mill was currently engaged in a value-added operation. All of the mills currently had good markets for their by-products.

There was a marked difference among the mills in the size of slabs and the volume of material going into the chipper. Two mills in particular were consistently producing larger slabs. This appeared to be caused more by the milling strategy of the sawyer than any characteristic of the logs. Recovery involves choices. Modern, well-designed sawmills do their recovery at the headsaw. Optimizers, thin kerf bandsaws, curved sawing, linear positioning carriages, etc., all help to maximize the amount of lumber recovered. The mills that were opening a smaller face in the log were consistently producing slabs that were too small to contain a recoverable product.

Each mill we visited had a unique system for handling their waste materials. Several had the conveyors carrying slabs and edgings sunken below the mill. None of them were designed to allow easy access to this waste stream. Only one of the five mills had a waste conveyor that was easily and safely accessible. Trying to access the waste at the other mills would place the picker in an unsafe position, in danger of being struck by moving logs, lumber, and machinery, and out of sight of the sawyer.

The mills had varying amounts of inventoried lumber. All had some amount of unsold lumber in odd lots. All of them produced considerable volumes of low-grade or pallet lumber. An inspection of the pallet lumber at each mill showed an abundance of material that potentially could be utilized in a value-added operation.

3. Availability of Raw Materials from Other Sources.

a. Chelsea Center report

In 1999 the Forest and Wood Products Institute produced a report on the availability of wood wastes in the state of Massachusetts. The report was part of a grant from the Chelsea Center for the purpose of researching the potential to create wood/plastic composite products.

The report identified six sources of wood wastes:

- Logging wastes
- Sawmill wastes
- Secondary wood industry wastes
- Used pallets
- Street and shade tree maintenance
- Demolition and construction wastes

Logging wastes include tops and branches, material not generally applicable to our study. The availability of underutilized material from the forest has been covered elsewhere in this report. Sawmill wastes have also been addressed.

Used pallets provide a potential source of recoverable lumber. This lumber has been cut from pallet logs or has been milled from higher-grade logs and has failed to meet the requirements for higher-grade lumber. The Chelsea Center study combined pallet waste material in the secondary wood industry category. They estimated that Massachusetts secondary wood products companies produce 1,917,480 tons of wood residues annually. These residues are in the form of sawdust, sander dust, wood chips, shavings, pallets, and cut offs. Most of these companies already recycle their waste. The most common use is for fuel, animal bedding, landscape mulch, and compost. It is not known what percentage of this material is in a form applicable to our study. According to the 1988 Yankee Forest Cooperative Directory of Secondary Wood Products Manufacturers, 151 firms in the three Southern New England states produce waste in the form of slabs, edgings, and trimmings.

Street and shade tree residues amount to an estimated 84,649 cubic yards of material per year. Much of this volume is in the form of chipped wood, bark, and foliage. The sources are commercial tree care and landscaping companies, land clearing, municipal tree care and recreation departments, and public utilities. The utilities account for 65% of the total volume. It is not known how much of this volume is, or could be, available in the form of logs.

It estimated that in the demolition and construction waste stream, clean wood waste amounted to 831,600 tons in Massachusetts in 1997. As of 1999 the average tipping fee for disposing of this material was $75.00 per ton, and some of the material has to be shipped as far away as Ohio. Based upon the amount of new home construction, they estimated that the construction wood waste portion of this stream amounted to 25,875 tons in Massachusetts in 1997. This includes clean unpainted dimensional lumber, plywood, OSB, and particleboard without laminates. Although this is a potential source of lumber parts, the material is not currently sorted at the source. As a result the clean wood that potentially could be utilized is mixed with dirty wood and other debris. This problem is even more pronounced in the demolition debris category.

4. Costs of Raw Materials

a. Logs

The base cost for logs would depend upon the stumpage price for standing trees. The stumpage price varies based upon species, size, quality, and accessibility of the tree, as well as its distance to the sawmill. Connecticut and Massachusetts have for a number of years surveyed foresters, mills, and loggers to track current stumpage prices. Appendix C includes three stumpage price reports based upon these surveys, from 1995, 1998, and 2000.

The surveys report median, minimum, and maximum stumpage prices by species and location (east or west of the Connecticut River). A look at the median and minimum prices from these reports (Table 5), for sales east of the Connecticut River, shows a general upward trend in median prices, particularly for the red oak and white pine, and also for the other oaks, ash, hard maple, and cherry, species not shown on the table. These are all considered to be the "higher valued" species in the Massachusetts forest. The median prices for the lower-valued species or products, red maple, beech, hemlock, pallet hardwood, and fuelwood, have remained relatively low, or, in some cases, have fallen slightly.

There could be a number of reasons for the lowest, or minimum reported stumpage prices, and not all of them directly related to the size or quality of the timber. There could be only minor amounts of the species in the sale, the access could be difficult, the logger may lack good markets for a particular species, or there may be a considerable distance to the sawmill. Nonetheless, the minimum reported price should be a good indication of the value of the small, and/or low quality logs sought for our purposes. We can also assume that the prices are those paid for grade 1, 2, or 3 logs (or their equivalent), since below grade logs would most likely be sold as firewood or pulpwood.

Table 5. Median and minimum reported stumpage prices ($/MBF) for selected species in Southern New England (east of Connecticut River), 1995 - 2000. Source, Southern New England Stumpage Price Surveys, Cooperative Extension, Universities of Connecticut and Massachusetts, third quarter, 1995, third quarter, 1998, and third quarter, 2000.

	MEDIAN PRICE			**MINIMUM PRICE**		
SPECIES	**1995**	**1998**	**2000**	**1995**	**1998**	**2000**
Red Oak	$250	$281	$350	$100	$50	$150
Red Maple	$40	$40	$50	$20	$20	$20
Beech	$37	$25	$32.50	$15	$20	$25
White Pine	$60	$80	$100	$35	$40	$25
Hemlock	$35	$40	$32.50	$30	$10	$20
Pallet Hdwd.	$30	$40	$40	$30	$25	$10
Fuelwood*	$7	$5	$5	$0	$0	$4

* $/cord

Stumpage prices for lower quality beech and soft maple, therefore, are currently around $20 to $50 per MBF, and lower quality white pine logs are from $25 to $100. Cherry, oak, and sugar maple have minimum values ranging from $50 to $300 per MBF. This is probably a reflection of the very high value of the top grade logs for these species. It may still be possible to obtain small or lower-quality logs of these species at prices comparable to those of red maple. Most below-grade hardwoods will fall into the pallet or fuelwood category (or they won't be harvested at all). Hardwood pallet logs have a current median value of $25 to $40 per MBF. The lowest reported prices for pallet logs range from $0 to $30. Fuelwood (probably all hardwood) prices have stayed steadily at $4 to $8 per cord (a cord will contain from 200 to 500 board feet), with minimum prices paid of $0 to $4. Pulpwood prices have ranged from $0 to $5 per cord, both in median and minimum values. The hardwood pulp market is limited in Southern New England. Apparently it is a bit stronger east of the Connecticut, based upon number of reported sales.

It is interesting to note the fact that there are several instances within the three reports where pulpwood, fuelwood, pallet wood, and hemlock, had a stumpage value of $0. This could indicate that it was important to the landowner to have these stems removed.

In order to get these logs to the mill, it will be necessary to factor in the logging and trucking costs. Logging will cost approximately $80.00 to $120.00/MBF, depending on the accessibility of the timber, the type of equipment being used, and the skill level of the logger. Trucking (within 50 miles) will cost from $30 to $50/MBF.

It is reasonable to assume, therefore, that fuelwood and pulpwood quality logs can be bought for about $10/MBF on the stump, and delivered to the mill for between $120 to $180/MBF. Pallet quality logs could be purchased for $35/MBF stumpage, and delivered to the mill for $145 to $205/MBF. It may also be possible to purchase pallet quality white pine within this range. The minimum value for grade hardwood logs would be at least $50.00/MBF. This would mean that they would cost at least $160.00 to $220.00/MBF at the mill.

b. Lumber

We are focusing on the lower valued lumber, hardwood lumber grade number three common, pallet lumber, and pallet cants.

The Weekly Hardwood Review (Nov. 24, 2000) reports the current value for kiln dried lumber in the Northern Region (New England, New York, the Lake States, Ontario, and Quebec).

Table 6. Value of 4/4" #2 Common, kiln dried lumber in the Northern Region as reported in Weekly Hardwood Review. Based on Gross tally prices.

SPECIES	$
Ash	560-610
Beech	315-355
Yellow Birch	580-630
Hard Maple	710-770
Soft Maple	475-525
Red Oak	880-935
White Oak	550-620

Based upon previous hardwood market reports, #3A Common lumber is generally 66% to 75% of the value of #2 Common.

Table 7. Estimated value of #3A Common lumber, 4/4, kiln dried.

SPECIES	$
Ash	400-450
Beech	205-270
Yellow Birch	380-475
Hard Maple	460-575
Soft Maple	345-395
Red Oak	580-705
White Oak	365-465

5. Summary and Discussion

The purpose of this project is to explore the potential for producing high valued dimension parts from under-utilized and low-valued forest products. We have in this section examined the potential raw material supply for the purpose of determining the best available source of material for the production phase of the project. The potential sources are logs from the forest, low grade lumber from the sawmills, or used pallets and pallet parts, cut-offs from secondary wood manufacturers, and logs from shade and yard trees.

The forest survey data we presented shows that the Massachusetts forest contains an abundance of low quality and under-utilized species and stems. Red maple in particular is available in abundance, has a relatively low dollar value, and is growing much faster than it is being harvested. Hemlock and beech are two other species that are abundant, low valued, and growing much faster than they are being harvested. There is also a large volume of northern red oak and eastern white pine in lower grade trees even though these species are higher valued and are being harvested at higher rates. In fact, there is an abundance of below grade, pallet, pulpwood and fuelwood grade stems available in all species across the board.

Our sawmill survey revealed that close to 50% of the hardwood lumber volume produced by Massachusetts' sawmills is in the form of pallet lumber or cants. The nineteen mills that responded to the survey (representing 40% of the state's lumber production) reported an annual production of 7.4 million board feet of hardwood pallet lumber.
We viewed pallet lumber at several mills and observed that there was considerable clear wood in many of the pallet boards.

We have found that there is a wide variance between mills in the production of recoverable slabs, edgings, and trimmings. In general, this is directly related to the investment the mill has made in primary recovery from the log. Mills that are sending large volumes of recoverable wood to the chipper have the option of investing either in better lumber recovery, or in recovery of products from the waste stream. Either option will require the acquisition of new equipment, the instigation of new production processes, and the retraining of employees. If they choose to attempt the recovery of products from the waste stream they will also need to research and establish new markets for the products produced.

There is a large amount of wood material available from the waste stream, and some of this material can be obtained for little or no cost. A good deal of handling would be necessary, however, to correctly sort this material, and new, and perhaps expensive, collection systems would have to be devised and implemented. Utilization of this material would also run counter to our goal of improving forest health and composition. Although there is a large potential source of material from shade tree and power line maintenance, demolition and construction debris, and used pallets, we felt that the goals of our project would best be met by focusing on forest-based sources of material. The issues of forest health and productivity are important, and will best be served by the creation of markets for logs and lumber.

Based upon these observations we have decided to utilize two species and two sources of material for our production process. The species are red maple (Acer rubrum) and northern red oak (Quercus rubra), chosen because of their abundance in the Massachusetts forest and because of the abundance of low quality material available within these two species. The sources of material will be pallet lumber and small below-grade logs. Pallet quality lumber is produced in great quantities by Massachusetts sawmills, and our observations have led us to believe it may be possible to profitably extract high quality products from this material. Likewise, small below-grade logs are
readily available and suited to value-added processes.

Many of the other potential sources (or species) of raw material were omitted only for reasons of expediency. We need to complete our study within a limited time period, which restricts our ability to look at a wider variety of materials. It would certainly be beneficial to look at a broader species group. White pine, hemlock, beech, and other hardwood species would all be suited to value-added manufacturing, and should be included in any future projects or studies.

We will conduct a demonstration of slab recovery equipment at a local sawmill. We will not look at slabs in detail, however. Although this material could be profitably recovered at some mills, the safety and cost issues related to acquiring the materials, the small size of the material, the limited supply, and the need for specialized equipment combined to make this course less desirable.

B. Local Wood-Using Markets

1. Introduction

We have attempted to describe the potential markets for wood components and panels, and to identify specific local markets for these products. This was accomplished through a review of existing literature, visits to secondary manufacturers, the development of a database of wood-using companies, and a survey of these companies. Our purpose was to identify specific markets for the products we will produce as a part of this project and to provide information of value to our primary forest products companies.

Our target products include wholesale hardwood dimension parts, turning blanks, bending stock, flooring, and paneling. With the addition of gluing we could add furniture panels and creative flooring.

There are multitudes of products that utilize small (usually clear), pieces of wood. Here is a short list:

- flooring
- paneling
- chairs/ fold-up chairs
- shelves
- tables/small drafting tables
- firewood carriers
- wooden toys
- pre-packaged kindling wood
- magazine racks
- treated landscape dividers
- planters
- lattice
- cutting boards
- picture frames
- candle holders
- bowls
- spoons and forks
- rolling pins
- wine racks
- coasters
- jewelry
- planters
- chess boards
- boxes
- buttons

Visits to local retail building supply companies revealed potential markets for pre-packaged flooring, paneling, and do-it-yourself kits. At Cowls' retail store in Amherst, MA, 3/4-in. flooring, 6 in. long and up was sold in small packages for $0.50 to $0.60 per square foot. Species were maple, ash, and oak.

The Independent Sawmill & Woodlot Management magazine in their August/September, 2000, issue included an article by Harry Watt entitled, "Adding Secondary Products to Your Sawmill Business Can Generate Extra Profits." Mr. Watt suggested the following products:

- Kiln dried rip strips - dried and ripped to specific widths
- Dimension blanks and glued panels - rough planed, ripped or glued to a rough width, and chopped to a rough length
- Mouldings
- Squares - blanks used to make turnings, cut to specific lengths

2. Mater Report

In 1988, Mater Engineering of Corvalis, Oregon was hired by the University of Massachusetts to investigate products and markets for the Western Massachusetts wood industry. Their report, "A Strategic Marketing Plan for the Western Massachusetts Wood and Wood Products Industry", provides valuable marketing information that is relevant to our project.

Mater assessed potential markets based upon the following criteria:

- Growth market
- Utilizes species available in Massachusetts, particularly hardwoods

- Utilizes low-grade and under-utilized species
- Not labor intensive
- Provides value-added products
- Local, regional, and national markets are available
- Can be developed for export markets
- Can be processed in Massachusetts or processing facilities can be developed
- Current manufacturing in Massachusetts can be expanded
- Distribution channels available or can be developed
- Requires relatively low investment

Twenty products that appeared to best meet these criteria were chosen. These products were then further examined to assess demand and supply sensitivities, identify the principal suppliers, prepare a competitor profile, and compare the Mass. Western Region with other producers. They were:

1. Decorative panels (character wood)
2. Hardwood furniture components
3. Upholstered furniture frames
4. Wood kitchen cabinets
5. Hardwood truck beds
6. Handyman parts
7. Stair parts
8. Millwork, including mouldings
9. Turnings
10. Pre-cut building market
11. Wood siding
12. Retail do-it-yourself market
13. Wood fencing
14. Hardwood flooring
15. Softwood flooring
16. Treated wood kits
17. Boat building components
18. Pallets and skids
19. Crates and boxes
20. Games and toys

Through a weighting process this list was eventually reduced to six products. Potential products were weighted based on the following criteria:

- Utilization of low-grade wood and underutilized species
- Modest resource and investment requirement
- Applicable for smaller companies
- Provides opportunities for reaching markets
- The products are all value-added
- The products are symbiotic

Based on the weighting criteria, the following products were subjected to in-depth analysis:

- Pallets and skids
- Handyman parts
- The retail do-it-yourself market
- Hardwood truck beds
- Hardwood furniture components
- Decorative "Character wood" panels

The in-depth analysis of these products is in Section X of the Mater report. Anyone interested in this subject is urged to read that report.

3. Hilltown Wood Users Survey

In August 1998 the Hilltown Community Development Corporation (CDC) initiated the "Hilltown Wood Project" to promote responsible forest management and to unite local wood producers, wood processors, and wood users to develop local economic relationships. The project area was eleven towns in the hill country of western Hampshire and Hampden counties. As part of this project the CDC first identified and then surveyed wood-using companies located in and adjacent to the project area. One hundred thirty-six companies were identified and surveyed by phone.

Thirty percent of the responding companies produced furniture, 23% were general contractors, 19% cabinet makers, 15% architectural woodworking companies, 9% fine woodworking, 2% timber framers, and 2% other. Twenty five percent of the companies used over 10,000 board feet of lumber a year, and another 57% used between 1,000 and 10,000 board feet. Forty-one percent purchased under 500 board feet at a time. Only fifteen percent purchased over 1,000 feet at a time. Eighty-five percent of the companies purchased their stock in Massachusetts. Ninety-five percent used New England source.

Approximately 15% of the volume purchased by these companies was maple (there was no distinction between red and sugar maple), another 15% was cherry, and over 10% was pine (includes native and non-native pine. Only 4% of the reported volume was eastern white pine). Red oak, white oak, birch, and ash amounted to approximately 5 % each.

Fifty-three percent purchased rough sawn lumber only, while 32% purchased surfaced lumber only. Of those 61% needed lumber surfaced on four sides (S4S), 13% used S2S, and 10% purchased S4S. Seventy-six percent needed kiln-dried lumber. Almost all of the companies purchased higher-grade lumber (select or better). A variety of widths, lengths, and thickness were purchased. The most common thickness was 4/4".

4. Directory of Secondary Manufacturers

In 1988 the Yankee Forest Cooperative Project (now the Southern New England Forest Consortium, Inc., or SNEFCI) compiled a directory of secondary wood products manufacturers operating in Connecticut, Rhode Island, and Massachusetts. For each firm included in the directory it lists the product produced, raw materials acquired, species used, and residues created and used.

Ranked by number of firms, the following is a list of the major wood products produced in this region:

1. furniture
2. cabinets
3. millwork
4. case goods
5. doors and windows
6. architectural woodwork
7. moldings
8. stairs

The rankings for the raw material used (whole wood products only, excludes engineered wood products):

1. lumber
2. dimension stock
3. turnings
4. blanks
5. blocks/cants/flitches

The ranking for the species used:

1. red oak
2. white pine
3. yellow birch
4. mixed hardwoods
5. cherry
6. hard maple
7. white oak

5. Plant Visits.

Eight wood-using plants were visited between September, 2000 and January 2001. The purpose of the visits were to learn of current practices for obtaining or manufacturing raw materials, and to assess opportunities for selling component parts.

Of the eight companies, five produce furniture, one produces caskets, one produces architectural millwork, and another produces dimension parts. All of them utilized grade lumber as their raw material. Three of the companies have their own dry kiln and one has its own sawmill. All of the companies are producing dimension parts in-house, though at least three of them also purchase some to supplement their own production. Only two of the companies burned their own waste.

The furniture companies tend to utilize what would in Massachusetts be considered minor hardwood species; yellow birch, white ash, and black cherry. Hard maple is also a common furniture species. The casket company uses these species as well as poplar and mahogany.

The architectural millwork company uses primarily white pine and mahogany. The dimension shop uses the common furniture species as well as soft (red) maple. The lowest grade purchased by these companies was #1 Common.

Most of the companies were quite satisfied with their in-house cut-up operation. They did not, however, seem to have a good handle on the costs of the operation or the yields they were achieving. With one exception, all of the companies have looked into outsourcing or already are outsourcing. One company already had purchased dimension parts from Russia and were awaiting their first shipment.

The reasons given for not outsourcing include the company's investment in equipment. For example, those with their own dry kilns did not want to see the kilns idle. They also felt they were better able to control the quality of the product, and they wanted to maintain the flexibility their own cut-up shop gave them. One company would continue to cut and glue-up lumber even after they had fulfilled their needs, resulting in a large inventory of panels, put by "just in case".

What we observed was that the cut-up operations in these companies consumed a large amount of space, not only for the operation, but also for the storage of the lumber. At least three or four men in each company were dedicated to cut-up the lumber and yet most of the companies were short staffed. A large amount of energy was used in the operation, and it also generated a lot of waste and only a couple of the companies were utilizing the waste for power. For the others, they had to pay to dispose of the waste.

The current situation, as illustrated by these companies, creates a very good opportunity for an independent cut-up shop to produce the parts currently being made in-house. The trend in the industry is toward outsourcing of these materials and even the companies that are beholden to their own shops now are going to have to reconsider as energy, labor, and transportation costs climb.

6. Wood Users Database

With the assistance of the Mass Natural Resource Center Cooperative (MNRC), and the Drawing Office of Northampton, MA, a database of almost 400 wood manufacturing companies was generated. The area covered was all of the New England states and eastern New York State. This list of 397 is perhaps 55-60% of the total available businesses. The database was developed using Filemaker Pro, version 5.0. The companies were identified through previous secondary manufacturing directories, membership directories (Wood Products Manufacturing Association and Wood Components Manufacturers Association), telephone directories, and word of mouth. The database contains address and contact information on the company and the products that they produce. If the company responded to our wood-users survey (see below) their survey responses are included in the database. Copies of the database on disk or in written form will be made available to any company requesting it. A list of the companies included is in Appendix D. The database will be maintained and updated by the Forest and Wood Products Institute.

7. Wood Users Survey.

During the fall of 2000, Shane Smith, a Building Materials student at the University of Massachusetts, conducted a phone survey of wood-using companies. John Tierney designed the survey, with assistance from Don Stone and Joe Smith, and the Wood Recovery Project Committee reviewed it prior to mailing.

The purpose of the survey was to describe the market for wood components and parts and to identify specific markets for local producers. From the database of 397 companies, 253 were identified as potential rough dimension lumber (RDL) users. Each of these 253 companies was called and 83 participated in the survey (33%). The survey questions and responses are listed in Appendix E.

The responding companies represented the following industry segments:

Table 8. Responding Companies by Industry Segment.

	No.	**%**
Furniture Makers	46	55.4
Architectural Woodwork	18	21.7
Miscellaneous Manufacturers	9	10.8
Parts Suppliers	5	6.0
Cabinetmaker	4	4.8
Shipwright	1	1.2
	83	100.0

Seventy-nine of the eighty-three companies used hardwood (95.2%), while 7 used softwood (8.4%) (4 used both). The majority of the companies (66 of 83, 79.5%) used grade lumber as a source material and produced parts in-house. Nineteen companies (22.9%) utilized dimension parts. A handful of companies both produced parts in-house and purchased parts at the same time. Only six companies utilized rough dimension parts. The other dimension users required S2S or S4S components. However, 43 additional respondents (51.8%) indicated that they would be interested in considering using rough dimension lumber.

Table 9. Survey Respondents source materials

	No.	**%**
• Source grade lumber	66	77%
• Source rough dimensional lumber	6	7%
• Source D4S lumber	7	8%
• Source D4S components	6	7%
• Edge-glued panels	1	1%

As our previous research had indicated, the most popular hardwood species within the furniture industry are cherry, ash, birch (primarily yellow birch) and hard maple. The Architectural woodworkers, cabinetmakers, and parts suppliers we surveyed also preferred these species. Red oak was the fifth most popular species. Twelve respondents (14.5%) indicated that they are already using soft or red maple. Twenty-eight additional companies responded that they would be willing to try red maple.

Table 10. Hardwood species used.

Species	Arch WW	Cabinet Makers	Furniture Makers	Misc. Mfrs.	Parts Suppliers	Shipwright	Totals
Ash	6	3	22	3	3	1	38
Birch	7		14		4	1	26
Cherry	9	2	26	8	2	1	48
Hard Maple	11		17	5	3		36

Red Oak	8	1	5	2	1		17
Soft Maple	2	2	3	3	2		12
Walnut	2		1				3
White Oak	2		1	1			4
Teak						1	1
Totals	47	8	89	22	15	4	

The companies purchasing grade lumber preferred the higher-grade material. Over half purchase FAS lumber. All but a handful purchase #1 Common or better.

Table 11. Hardwood lumber use by lumber grade.

Grade	Arch WW	Cabinet Makers	Furniture Makers	Misc. Mfrs.	Parts Suppliers	Shipwright	Totals
FAS	6	2	21	6	2	1	38
Sel&Better	5	2	7	1			15
#1Common	1		11	1	1		14
#1&#2Com	1		1				2
#2Common			1	1			2
Industrial							
Pallet Grd							
C&Btr							

The majority of the companies purchase between one and three thousand board feet a month. Sixty-five out of seventy-five purchased between one and six thousand board feet per month.

Table 12. Monthly Volume Purchases by Company Type

Volume in BF	Arch WW	Cabinet Makers	Furniture Makers	Misc. Mfrs.	Parts Suppliers	Shipwright	Totals
> 500	1	1					2
500-1,000	1		3				4
1,000-3,000	11		24	7	2	1	45
4,000-6,000	1	3	13	1	2		20
7,000-10,000			1				1
10,000-50,000			1	1	1		3

Forty-seven companies reported that they currently were using certified wood products. Twenty-three companies responded that high price was a barrier to using certified products, while another five cited a lack of supply as a barrier to using these products.

In order to gather more complete information on the potential use of component parts we made follow-up phone calls to the forty-six companies that were using, or had expressed an interest in using dimension parts. We asked them in what form they would prefer to receive the parts. Again, only a handful were interested in rough dimension lumber. The majority prefers a more completely processed source material, as shown below. Some respondents checked more than one box, so we have more than 46 total.

4 - Rough Dimension Pieces
7 - Dress 2 Sides
36 - Dress 4 Sides
18 - Exact Components

The companies cited 'quality and accuracy' as being the key variable for selecting a source of wood components. Below that, on time delivery and competitive pricing were given equal weight.

One purpose of the follow-up call was to collect more specific pricing information. What price, above a client's current source material cost would respondent pay for RDL, D2S, D4S, or Exact Components? That price differential would indicate, from that company's point of view, their perspective of a value added to the source material to get it from rough grade lumber to the preferred condition, or "dressed" source material.

For instance, one customer buys heavy 4/4 (dry) skip planed to 7/8" thickness and ripped to 3", 4", and 6" widths. He then runs these pieces through a four-sided moulding machine, and a cutoff saw to obtain exact sized blanks to make his furniture parts. He pays approximately $4.50 - $5.00 / board foot in the aggregate for all his pieces. This is approximately $2.25 - $2.50 above Select and Better price for Grade lumber. So this customer is willing to recognize a value-added of $2.25 - $2.50 per board foot in order to more conveniently "size" grade lumber input to his process. This customer was the "high water mark" for the 46 we've been pursuing.

The low end of the spectrum is a pine producer who buys white pine at $0.50 - $0.70 per board foot. We did not get a grade indication here. He felt that a fair price for thickness and rip preparation was $1.15 - $1.25 per board foot. So his cost in the end for this dimensioning was attractive to him at $1.65 per board foot.

The median mark was several respondents who felt a range of $1.25 - $2.25 was fair value added. A point to remember is that respondents were identifying a value-added to the price they currently pay for largely high-value grade lumber. In most cases, these purchases are for FAS and Select and Better Grades. For example, if FAS is selling at $2.25 per board foot, the dimension part value would be in the $3.75 - $4.75 range. This could be the target value for finished dimension pieces produced directly from lower grade and small logs, rather than pieces produced from grade lumber.

Some of the respondents are purchasing #1 Common and a few, even lower grades, and we will note that in developing what are attractive prices for our processed input materials. We are also talking with the respondents about yields from their source material as a way of getting at eventual useful or productive volumes of source materials and the costs associated with them (i.e., If a customer recognizes that they only get a 55% yield from the #1 Common source material, and it costs them a significant labor input to achieve this, then the actual cost of deriving the eventual useful input components is the total of all the material costs, including labor and variable overhead, and the cost of disposal or reutilization of 45% or the raw material that enters their manufacturing process). Most manufacturers we surveyed did not seem to have a clear or precise estimate of the cost of internally produced components and dimension pieces.

This is a tough point to speculate on at the moment, but it looks like there is sufficient volume. The original survey may not have captured accurate measures of usage volume of lumber or dimension and component parts. For example, one manufacturer reported in the follow-up phone survey purchasing 40,000 to 50,000 hard maple panels per year and 100,000 small dimension pieces in ash, yet these volumes had not shown up in the original survey figures.

45 of the 46 respondents reported the following monthly usage figures.

Table 13. Monthly consumption of RDL (board feet).

MONTHLY CONSUMPTION	# COMPANIES	MIDPOINT	TOTAL
500 - 1,000	1	750	750
1,000 - 3,000	22	2000	44,000
3,000 - 4,000	5	3500	17,500
4,000 - 6,000	11	5000	55,000
6,000 - 10,000	1	8000	8000
10,000 - 50,000	5	30,000	150,000
			GRAND TOTAL 275,250

The follow-up phone surveys revealed a high level of interest and support for the idea of producing hardwood dimension finished pieces and components produced locally from lower grade and small logs. There was also no indication of a willingness to subsidize such production with higher prices, but if the price were competitive, meaning that it made sense compared with their known costs, respondents from this admittedly small sample expressed an encouraging level of receptivity.

8. Summary and discussion.

Our research has given us a picture of a large and varied secondary wood-using industry in our region that could provide an opportunity for the establishment of a dimension part operation utilizing non-traditional materials. The majority of these companies are still producing their own component parts in-house from grade lumber, providing an opportunity for the entrepreneur who can convince some of these companies to out-source these materials. A substantial market also exists of companies already purchasing component parts. Although the species preferred by the local wood using companies are not necessarily the same ones that we have targeted, the preferred species are available locally, and an established business producing component parts may be able to improve demand for other species once the business is established. The survey also showed that the region's wood-using companies would prefer to use environmentally friendly products provided they were accessible and reasonably priced.

The survey did not, however, provide any clear information on the dollar value of the component parts to the wood using companies. Part of this is because the majority of the companies are still purchasing lumber and producing the parts in-house, so they may not have an accurate idea of the cost of producing those parts. The wide variety of sizes and species being used also makes it difficult to pin down the value of this material. It is, however, essential information that will need to be researched further, for it cuts to the heart of our project. While there may be sufficient demand to support a business producing parts, the market price for the parts will determine the feasibility of producing them from low-valued material.

C. Related Projects and Businesses.

1. Wood Recovery Trip August 7 - 10, 2000

<u>a. Purpose</u>

Members of the Massachusetts Wood Recovery Project committee visited Tennessee, Kentucky and Indiana from August 7th to 10th, 2000 for the purpose of viewing wood products companies engaged in value-added activities. The members were: Rob Rizzo of the Forest & Wood Products Institute; Gordon Boyce, MA Marketing and Utilization Forester; John Tierney of The Drawing Office; and Dean Huber of the US Forest Service, Forest Products Technologist for the northeastern area. Stephen Bratkovich, Forest Products Specialist from the US Forest Service, St. Paul, MN office accompanied the group. Steve had suggested many of the stops on the trip based upon his previous experience with value-added projects.

b. Manufacturing Processes Evaluation

Prior to the trip the group decided to examine the following aspects of value-added dimension stock processes: raw material procurement, manufacturing options including the manufacturing philosophy of mill owners, yields, drying, labor availability and costs, and merchantability. Varying marketing considerations that were reviewed included: distance from markets, prices, availability of continuous market demand, specifications and/or other requirements of buyers, and alternatives to producing value added dimension parts. These options were included in the research to better understand the feasibility of establishing such a venture in Massachusetts.

Over the course of two and a half days our team visited six manufacturing facilities. Four of these were hardwood sawmills, one was a hardwood strip flooring manufacturer, and the other was Aristokraft, a large cabinet producer that purchases large quantities of rough dimension lumber (RDL).

Two of the hardwood mills are currently producing RDL for sale to Aristokraft. The flooring plant also produces a small amount of dimension from their offal. A third mill formerly produced for Aristokraft, but has recently re-fitted the mill and now focuses on maximizing yield of grade lumber. This mill does, however, continue to take in slabs from other mills and turns those slabs into pallet parts.

This company purchases slab wood from 8 other area sawmills to be processed into pallet parts and chips. A separate chipper has been set up to process slabs due to the average chip price received at $24/ton FOB mill. A separate high production cut up shop has been established to process slabs for pallet parts. "Baker" equipment is used for two horizontal resaw stations, two "Mereen-Johnson"vertical bandsaw edging and ripping stations are used, and multiple "Ultimizer" chopsaws.

The proximity of the businesses visited to the Aristokraft plant provided these companies with a reliable market for rough dimension lumber (RDL). They were supplying RDL exclusively to Aristokraft Inc. for the following reasons:

- Close proximity to market; they were all within 150 miles.
- Willingness of buyer to purchase mixed loads of varying volumes and species; most suppliers concentrated on three to six size specifications.
- The average price paid for Red Oak RDL is $1800/MBF and $1400/MBF for Red Maple.

Aristokraft is a vertically integrated company with a number of manufacturing facilities across the United States. The Crossville Tennessee facility produces cabinet parts to supply their assembly plants. Current production from RDL is 4 - 5 MBF, and they anticipate procuring even more RDL on an annual basis. RDL specifications call for clear 1 side, with minimum defects on the back. They purchase red oak, red maple, and limited amounts of Hard Maple (*Acer Saccurum*). All parts are palletized on standard 42" x 42" pallets, shrink-wrapped, and tagged with one size only per pallet. Aristokraft seems quite flexible on which sizes an individual producer makes. Most producers seem to concentrate on 3-6 sizes.

Red oak is purchased in 14 different sizes and averages $1800/MBF FOB producer, and Red Maple (*Acer Rubrum*) in 11 sizes with an average price of $1400/MBF. They have established an incentive program for yields over 90%.

RDL makes up 30% of their annual production; the balance comes from green #1 Common lumber in lengths of 8' - 16'. Total kiln capacity is 600MBF with an additional 2MMBF pre-drier. All waste wood is burned in two 550 HP boilers feeding a steam turbine and generator which produces 40% of their electrical needs, and the steam for the kilns.

All lumber that is processed in the cut-up shop is first ripped to specified widths, then cut to length. "Group Seven Systems" and "Nova Technologies" equipment is used, and the operations are assisted by "AOK Detection System", which utilizes lasers, x-ray technology, and high-speed color cameras to automatically identify all defects, both external and internal at a speed of 165'/minute. "Color Evaluation System" equipment is utilized to sort red oak into 27 different color sorts using high-speed cameras and fiber optics

One of the mills supplying Aristokraft with RDL mills 2 million board feet of principally red oak and soft maple lumber per year while producing about 10,000 board feet of RDL/month. The RDL is recovered from the waste stream by manually pulling edgings and heavy slabs. The cut up operation consists of a horizontal band saw and two trim saws. The slab fragments in the first building by the headrig are routed to a sorter table where the unusable pieces are fed to a chipper chain. Some pieces go to a storage cart of long-edge strips and the rest of the pieces to a recovery processing setup. The setup used at least one-two bandsaw rip, two crosscut stations, and a complicated series of conveyors to bring components around for a second pass at each station, waste cutoffs to a chipper, and chutes or metal slideways to bring cut sizes to individual piles. They work with red oak and red maple and concentrate of 6-9 sizes (2-3 widths and 3 lengths).

All RDL parts were palletized on 6' pallets with 3 stickers per part. The parts were dried with full-length lumber in 50 MBF de-humidification kilns. The parts were not endcoated. The RDL material was stacked in the center of the kilns and dried with the full-length material dried at either end of a kiln load. The owner felt that the ends of the kiln where the fans were located were the most active air exchange areas, and the center of a kiln was a more hospitable place for the short timber.

The second mill producing RDL as a recovery product mills 5.5 to 6.0 million bd. ft. of lumber per year. They also produce 800-1200 bd. ft. per shift of 4/4 RDL in several dimensions. The RDL was produced from slabs and edgings. Log breakdown is on a bandsaw headrig, cants are further processed on a band resaw and all lumber passes through a two-saw edger and trim saw. They intentionally slab heavy at the main mill knowing that the slabs are going to the rough mill for further processing.

The rough mill consists of almost exclusively Baker Equipment. The single exception observed was an "Industrial" chop saw. The equipment includes a horizontal band, a twin vertical band, two chop saws and associated conveyers. They are very happy with the Baker products. They target 6-8 Aristokraft sizes in their rough mill production. . Slabs are ripped into 3, 4, and 5" widths and sorted for lengths of 24, 30 and 33". The RDL is rough-sawn, not D4S like the Cumberland products. It is dried, sorted for size, and defect-sorted prior to drying. It is wrapped on pallets for shipping and delivered in cube-shaped blocks. On inspection of the small amount of material ready to deliver here, the product looked terrific. There was virtually no end checking in drying short pieces. Aristokraft buys their parts for $1.80 per board foot. Production in the rough mill was about 1200 bd ft / day on the days they operated. The crew floated between main mill, drying operations, and rough mill.

This company uses conventional kilns for their sawmill production, and a 1600 bd. Ft. Woodmizer Inc. vacuum kiln for the RDL. Due to the physical constraints of the Woodmiser kiln, the parts have to be hand loaded/ unloaded. This process requires 16 man-hours to complete. All parts are endcoated before drying. Full charge of parts in this kiln is 1800 BF and dries in 2-7 days (for 4/4 material) depending on amount of pre-drying in "T" shed. They will not dry parts in their conventional kilns. They never accumulate enough parts for a full charge (30 MBF) in any of their 4 lumber kilns, and have had bad luck drying mixed charges of parts and lumber.

The company utilizes a "Converta Kiln Inc" wood gasification system to provide steam for the lumber kilns. The system uses sawdust and scrap wood up to ½". It is an 80 HP boiler that consumes 700 lbs./hr of sawdust. Wood chips are not typically used for fuel in the area because existing chip markets net producers $24/ton FOB, and the chip market is only 38 miles away.

The situation for these mills was also much different from our local mills in regard to wood chips. The sawmills average $24/ton FOB mill or $27/ton delivered for hardwood paper quality chips. Most have a long-term contract with large paper producers such as Willamette Industries. All of the mills visited were within fifty miles of a chip market.

There appears to be no shortage of viable lumber markets in the region. This holds true even for lower grades such as #1C, #2C & #3C. Of the few manufacturing facilities visited, Aristokraft purchases 8 MMBF annually of #1C, and Cumberland Lumber purchases 26 MMBF of #2C & #3C annually.

The sawmills visited procure logs from a radius of 100 miles. Differing soil classifications, terrain, and a wide range of harvesting equipment allows for an uninterrupted harvest. This can alleviate price fluctuations in raw material during times of high precipitation. Producers also indicated that the average log size is 150 board feet, Doyle Rule, and log grades were of high value. Producers also verified that the top grade of logs cost $1000/MBF delivered. This can be substantially lower than in the Northeast. One producer also pointed out that they have exclusive timber rights to one parcel that is in excess of 24 thousand acres.

Although producers indicated labor shortages as a problem, no one mentioned that the cost of labor was limiting production or profitability.

c. Summary

A number of factors will influence the feasibility of RDL production in the Northeast. Variable costs such as electricity, labor, raw material costs, distance to markets, etc. combined with the fixed costs of production will affect gross margins. Studies have shown that the production of RDL from NHLA #3, #3A, and #3B hardwood lumber cannot economically occur simply because the cost of production is greater than the value of parts produced. Cumberland Lumber as described earlier in this document has been able to produce RDL from the lower grades of NHLA lumber because RDL was outfall from their strip flooring production. Currently no producers in Massachusetts are capable of duplicating this production model.

To further illustrate the economic concerns associated with the production of RDL from low-grade lumber, it should be noted that Aristokraft Inc. relied on #2 lumber exclusively to supply their highly productive, mechanized cut-up shop. The 'state of the art' equipment utilized at this facility can process low-grade lumber efficiently and effectively, but the percentage of recovery from #3 lumber does not make this a viable economic alternative.

All the other producers visited were recovering RDL from 'heavy' slabs from the head rig and edgings. One producer, Etienne's Timber Harvest Inc., stopped producing RDL after the complete re-building of the sawmill with a linear positioning carriage with computer aided first face opening scanner, and a line-bar merry-go-round resaw to recover as much grade lumber as possible. Most modern hardwood production sawmills now employ these tools to increase the percentage of FAS, Select and #1 NHLA grade lumber from their typical log run.

RDL production is possible for sawmills in Massachusetts if they invest a minimum of $100,000 for breakdown machinery. Typical output from this modest investment would be 1000 bd. ft./day of RDL for 4 employees using the 'typical' Baker Inc. style machinery. A building, forklift or dry kiln is not reflected in this price estimate. Grade yields of NHLA FAS and Select lumber will decrease proportionally to the volume of RDL produced from heavy slabbing. Therefore, an economic alternatives analysis should be performed to quantify the loss of gross margins from the sawmill's primary income objectives.

The next logical step will be to process the information gathered from the current study and disseminate it to the sawmill community in a business plan format along with a description of economic incentives that may be available through various state and federal agencies or programs.

D. Literature Review

1. Introduction

The potential for producing furniture dimension parts from small or poor quality logs has been a topic of interest for many decades. In our research we found articles on the subject dating as far back as 1923 (Production and Use of Small Dimension Stock in the Chair Industry, by A. Upson and A. Benson). This interest stems from the long-recognized need to utilize the abundant volume of poor quality trees (particularly hardwoods) on both managed and unmanaged forests. Also of concern was meeting the needs of the secondary wood industry for clear wood parts, reducing wood wastes, and improving sawmill yield and profitability.

> "The Forest Service has for many years been fully cognizant with one of the vital problems with which the lumber industry is confronted - that of ways and means of profitable disposition of No. 2, No. 3, and cull logs, so-called; of heavy slabs, wide edgings, and long trimmings; and of the comparatively enormous production of low grade lumber and that 'below grade.'....In other words, for every 380 board feet of lumber manufactured, 620 feet are lost or wasted in the woods in the form of bark, stumps, and logs, or at the sawmill in the form of sawdust, heavy slabs and edgings, long trimmings, and lumber of unmarketable quality." (A. Upson and A. Benson, 1923. Production and Use of Small Dimension Stock in the Chair Industry. Association of Wood Using Industries. Chicago, IL.)

We have conducted a review of this literature to provide a framework and background for our project. We also wished to compile a collection of reference materials that would be accessible to people interested in further pursuit of this subject. We have included our full bibliography with this report, compiled a searchable database of the articles in the bibliography, including abstracts, and will maintain copies of the literature at the Forest and Wood Products Institute that will be made available to anyone interested in the subject.

A full review of the pertinent literature is included in Appendix F. The following is a short summary of that report.

2. Sawmill production of dimension parts

Several systems have been devised over the years for producing wood products from non-traditional materials. These include System Six, Green Dimensioning, and Maximum Tree Use. The driving force behind these systems is the need to better utilize our wood resources and decrease wood wastes. The authors will also point to the increasing demand for small wood parts from the secondary industry and the move within that industry to outsource the production of these parts.

On the downside, establishing a dimension operation will create a whole new set of problems for the sawmill operator. Several proposals are made in the literature for the set-up of a cut-up operation, but there is no one right way to do it. The sawmiller will essentially be covering new ground. In this unfamiliar territory they will encounter increased labor and handling costs from sorting stacking, moving and storing small pieces of wood. They will need to take a new approach to drying wood, as they most likely will be putting small pieces into the kiln instead of lumber. They will be subject to a greater risk of losing the value of their product in the kiln. On top of all the new production headaches, the sawmiller will also be entering a new and unfamiliar marketplace that has a language and culture much different from the one he is used to dealing with.

The literature covers the establishment of both sawmill based and independent operations. It provides ideas for acquiring raw materials, milling logs, drying lumber or parts, producing dimension parts and panels, establishing and servicing new markets, and it also includes extensive discussion of the economics of such an operation. We will present here the research and ideas most relevant to our project.

3. The Raw Material Supply

There is an abundance of small and low quality wood growing on our forestlands and it is of critical importance to the forester to find means for economically removing this material from the forest. This argument has been made and repeated in many of the articles that we have read, dating back to the 1920's. This abundance is easily established through analysis of Forest Service Forest Inventory data. In section II of this report we analyze the forest statistics for Massachusetts to show the relative abundance of these materials in our state at this time. As it is the natural course of forest growth to produce a large percentage of coarse and lower-quality material over the life of the stand, it is reasonable to assume that there will be a continuing supply of this material through the foreseeable future. In fact, many sources site the belief that the percentages of these materials in our forests is increasing. Our main concern then, has been the ideas put forth governing the size, quality, and form of the raw materials best suited for this process.

Many studies looked at the potential for utilizing bolts rather than logs. The reason for this is that it is possible to improve the quality of a log by bucking it into shorter lengths. Sweep and crook, in particular, can be removed by shortening the log, as can gross defects, and smaller defects can be placed at the ends of the bolts.

An equal number of studies look at the use of lower grade logs, so there is no consensus on the size of the material used. What is most important is that the material be suited for the products that are being produced.

4. Log Breakdown

Creating valuable products from low-valued source material will require new methods for log breakdown and drying. Many authors pointed out that milling to achieve the highest yields in NHLA grade lumber decreases sawmill recovery, and that higher yields of saleable end-product can be achieved by cutting directly for the market. All agree that the profitability of an operation will increase if the primary log breakdown is dictated by the final product to be produced.

Logs must be processed through the sawmill efficiently with the emphasis placed on wood conversion and yield rather than on the production of grade lumber. Ignoring grading rules and cutting for maximum yield will increase yields and save costs by not devoting labor and facilities to grading lumber.

Many authors suggest the use of live-sawing (through and through). Several different studies showed that most logs of all grades yield higher total values if live-sawn. They add that all researchers have noticed a tendency for live sawing to produce slightly lower volumes of the upper two lumber grades, increased volumes of the intermediate grades, and substantially lower volumes of the lowest grades. Minimizing or doing away with the edging of boards has also been shown to improve yields.

5. System Six, etc.

System-6 is a process developed by the USFS Forest Products Lab at Princeton, WV. It involves the production of standard-sized furniture panels from small and low-quality logs. With this system the sawmill produces two-sided cants which are sold to a dimension manufacturer. The cants are then gang-ripped into boards, which are then dried and defected, with the clear parts used to make glued-up panels of several standard sizes (Reynolds, et. al. 1983). System Six was heavily promoted by the Forest Service in the 1980's. We have not been able to find any examples of businesses using this system today, but much of the information printed on this subject is applicable to our efforts.

Standard blanks are pieces of solid wood (which may be of edge-glued construction) of a predetermined size and quality. Certain standard sizes for these blanks have been proposed based upon the research into industry needs, but we found no evidence that they have been adopted or that anyone was currently producing them.

Green dimensioning is the name given to the sawmill production of green dimension parts. This process would require that the sawmiller acquire new equipment (chop saw and rip saw) and dedicate more space for materials handling and storage.

J. Hamilton (1970) coined the term, "Maximum Tree Use " for a concept of hardwood dimension production that uses the tree stem as the prime raw material rather than grade lumber. According to the author, this system: 1. Uses more of each tree, 2. Obtains more effective use of low grade trees, 3. Exerts good control over cuttings yield by selecting and cutting bolts to a quality standard, 4. Provides large volume dimension production capacity by proposing a fast, primary sawing system, and 5. Provides an efficient dimension production method employing a rip-full board-length-first, sawing system.

6. Potential yields.

One large problem with working with low-quality logs and lumber is that they contain a large number of defects. Several researchers, however, have shown that it is possible to profitably break down this material into clear component parts. The suggested procedures for achieving this rely on the methods discussed above; milling for the end product rather than for grade yield; utilizing short logs or bolts to minimize sweep, crook, and gross defects; and live sawing with no or minimal edging. Carefully selecting the input material is also important. Whatever the system used, the yield is also going to be influenced by (1) the quality of the lumber or log input, (2) the cutting bill, and (3) operator efficiency.

We cited several studies that showed acceptable yields of dimension parts from low-quality material utilizing these methods. In all cases it is not the board foot yield per se that is most important, but the percentage of profit that can be gained, and the literature supports the proposition that these systems can be profitable.

7. Kiln drying

With the exception of green dimension parts, kiln drying is an essential component of producing quality products. The main question then, is whether to dry the material before or after defecting the lumber, or, is it better to dry the lumber or the parts? The basic principles concerning these matters are the same for parts as for full-sized lumber, but potential problems are magnified by the small size of the parts and their increased value per unit of production.

The movement appears to be very strongly leaning towards drying of the parts rather than the lumber, which emphasizes the need for dry kilns on site. The major points emphasized are the need to install proper handling procedures. The parts should be sorted by species, thickness, and width, stickered immediately after sawing or defecting, and placed within a controlled climate environment or in the kiln within one day of sawing.

Some mills end coat the parts prior to drying; others find this unnecessary. End coating appears to be more advantageous if there is a long delay in accumulating a kiln charge.

As with normal lumber, stickering is important. All parts need to be supported, the stickers need to be properly aligned, and weight must be added to the top course to inhibit warping. This is problematical with conventional stickering systems, but several mat systems have been developed that make the stacking and drying of parts easier.

8. Markets

The actual need for parts by the secondary industry has never been quantified. The multiplicity of products produced by the industry creates demand for a multiplicity of parts. There is very little standardization of part sizes. Knowing the quantities, qualities, sizes, and shapes of parts used in the industry would allow for more efficient uses of wood resources.

The literature describes the market as: 39% furniture; 27% millwork, trim; 21% cabinets; 9% decorative & specialty. 19% of the market is in edge-glued parts, 12% in cut-to-size blanks, 11% in moldings, and 10% in cabinet parts.

The approach put forth by the System Six authors was to find standard sizes of panels that could be utilized by a number of secondary manufacturers and produce these in quantity. There is a lot of literature on this subject, but we were unable to find any evidence that these ideas are being used in the marketplace.

Other authors point to the fact that the majority of the parts used by the secondary industry are relatively small. Excluding flooring, 50% of all cuttings are 4 inches or less in width, 33% are from 4 1/4 to 8 inches, and only 17% are 8 1/4 inches or greater. Similarly for length, excluding flooring, 40% of the volume of the material used by the leading industries is in cuttings 24 inches or less in length, 40% is in lengths 24 1/4 to 48 inches, and only 20% is 48 1/4 inches or greater. This variety of sizes can be a problem for the businessman, but it also provides the opportunity to improve yield by matching sizes to the characteristics of the raw material.

Production of dimension parts at the sawmill creates a number of marketing challenges. The sawmiller will have his work cut out for him as he tries to become established in this new market. This will be magnified if the customer is also new to outsourcing these materials. The dimension customer, as well as the mill, will need to handle the material differently as they are probably used to processing long lumber. Secondary processors also might not have a good handle on the costs of producing in-house, so they can't adequately assess the value of buying parts.

Other challenges for the sawmiller include: a lack of knowledge of standards; prices must be competitive, and quality must be high; on-time delivery; the multiplicity of lengths and widths; sawing pattern differences; and employee skills.

9. Economic analysis

The literature contains several studies into the profitability of producing dimension parts from low-valued materials. Included are several plans for model plant layouts, and economic analyses of different set-ups and different source materials. Although the numbers might be outdated on some of these articles, the general plans and discussions may be of interest to someone considering such a business. These articles are referenced in the Appendix, and many of them are on file at the Institute for those who wish to refer to them.

10. Summary and discussion

The literature provides ample support for the feasibility of producing dimension parts from low value logs and lumber. Although this idea has been much discussed in the literature for a number of decades, it appears that the industry, both primary and secondary, has been slow in accepting it. Be that as it may, the literature does provide a wealth of research and ideas that the entrepreneur should review before embarking on a venture into this field. They will find there valuable guidance on how to choose and prepare the raw materials, and on production and drying methods. One aspect of the process, however, that does not seem to be covered in depth in the literature, is a reliable description of the marketplace for small wood parts. As mentioned earlier, this may be because of the multiplicity of companies and products that make up this market. It is essential, however, that the market be well defined and understood before any venture is initiated.

IV. Demonstrations

Two separate demonstrations were conducted during this project. One was a demonstration of Baker recovery machinery, which was intended to provide local sawmill and wood recovery businesses with the opportunity to see the machinery in operation and to talk with Baker representatives.

The second demonstration was actually the culmination of the entire project, the production of dimension parts from low-quality source material to fill actual orders from secondary wood manufacturers. The purpose of this demonstration was to gather the information needed to provide a model for a Massachusetts value-added business.

A. Baker Equipment Demonstration

During the information collection process we repeatedly encountered companies using Baker Equipment. The Baker saws are durable, versatile, and relatively inexpensive. When we decided that it would be beneficial to demonstrate wood recovery machinery in Massachusetts we naturally approached Baker, and they readily agreed to assist.

As we mentioned earlier in this report, we observed a wide range of recovery practices in the sawmills that we visited. We have concluded that mills that wish to improve their recovery practices have the option of attempting to maximize the lumber yield from the log or of recovering valuable products from their waste stream. The Baker machinery would demonstrate the latter.

Roberts Brother's Lumber is a sawmill in Ashfield, MA, producing 7 million board feet per year. We chose this as the site for our demonstration because we had observed that there was a good quantity of recoverable material in slabs and edgings that were currently being chipped. The mill setup also provided safe access to the waste conveyors.

Prior to the demonstration we visited Robert's mill to pick wood from their waste stream. The mill was cutting red oak on that day. One man stationed at the waste conveyor just before the chipper collected one cord of wood within seventy-five minutes. The specifications were that the pieces be at least 1.5 inches thick, 1.5 inches wide, and two feet long. The mill produced 1,250 board feet of lumber during that time.

It should be noted that after we left, the mill attempted to augment our supply by picking two additional cords of wood. They did not, however, adhere to the specifications, and a lot of unusable wood was included in their bundles, emphasizing the need for careful identification of usable pieces.

The demonstration was held on Monday, May, 7, 2001. Baker Equipment provided two saws; The Baker 'A' Horizontal Bandsaw, and the Baker Scragmill, model BSCR-O. The Bandsaw was valued at $11,000.00, which included $7,500 for the basic machine, $2,500 for the return, and $1,000 for the power hold-down. The scragmill was valued at $19,800.

Three men were needed to operate the saws. The slabs were first run through the horizontal band saw, and then through the vertical saws, producing 1 1/8" squares of various lengths. The machinery was operated sporadically throughout the course of the day, as we were waiting for an audience before proceeding. There was also much discussion between runs. In seventy-five minutes of operation over the course of the day they produced 328 1 1/8" turning squares 14 1/4" and 25 3/4" in length (57 board feet). At a value of $0.023 per inch (kiln dried) the squares had a potential value of $140.57 (the value of the wood as chips was approximately $22.00).

The Baker people rejected almost half of the pieces we had picked because of thickness, length, or shape. With a better understanding of the machinery we would have done a better job of picking pieces.

At the end of the day we took a soft maple cord log, cut it up into four-foot bolts, and then ran those through the scragmill, producing 1 1/8" pallet boards. The four-foot length was the longest the machinery could handle with the particular set-up we had. It could, however, handle diameters up to 20 inches.

B. Value-Added Production of Dimension Parts.

1. Introduction

Our two goals for this project were:

Goal 1: Extract high-valued wood from low valued logs and lumber, and
Goal 2: Create market links between local producers and regional wholesale and retail buyers. Create demand, and a market, for several new products.

Under those goals were the objectives of accumulating cost and yield data for the purpose of preparing a business and marketing plan, and of producing prototype pieces or having secondary manufacturers produce prototype pieces with our products.

Based upon our research we decided that we would use two sources of materials, pallet lumber, and pallet grade logs. These are both available in abundance in the local area, and landowners, foresters, loggers, and mills would all benefit from improved markets through value-added processes for these products. We furthermore decided to concentrate on red maple and red oak. Again, these are two very common species, and, from our contacts with secondary manufacturers, we felt confident that we could procure orders for these species.

The pallet lumber was purchased from Hubbard Forest Industries. We chose from lumber already milled and stacked, taking a straight run of pallet lumber just as it had come off the green chain without any further sorting or culling. We received 3305 bd. ft. of red oak, and 4025 bd. ft. of red maple. This lumber was then dried to 8% moisture content in Hubbard's kilns.

The logs were purchased from the Mass Natural Resource Cooperative, a cooperative of local loggers and sawmillers. The logs were harvested from the Quabbin Watershed (a green certified property) as part of a silvicultural thinning. We specified that the red maple logs should be 6 to 12 inches in top diameter, 8 to 12 feet in length, and free of excessive crook or sweep. We requested red oak logs that were 6 to 10 inches diameter, 8 to 12 feet long, and below grade. 5445 bd. ft. of red oak logs, and 4555 bd. ft. of red maple logs were transported from the Quabbin to Hubbard's mill.

There were 179 red maple logs, for an average log scale of 25 feet. There were 314 red oak logs containing an average volume of 17 board feet. The red maple logs were milled into 4/4 lumber and stickered without any sorting. The red oak logs were milled into 5/4 lumber. The logs yielded

6310 bd. ft. of red maple lumber, and 6710 bd, ft. of red oak lumber. The lumber was then dried in Hubbard's kilns.

In the meantime, we had solicited orders for red maple and red oak parts from our list of secondary manufacturers. We received orders from seventeen companies for 104 different parts (a list of these companies and their orders is included in Appendix G). The parts requested included turning squares, panels, blanks, stair treads, and rough dimension lumber.

From this list we picked the orders we felt we could best fill based upon the characteristics of our source material. We were restricted first by the thickness of the lumber. The pallet lumber was of varying thickness, averaging 1 1/8 inches. For reasons of cost and efficiency we could not vary the thickness of the lumber milled from the logs, and based upon the orders received chose 4/4 for the maple and 5/4 for the oak. The character of the lumber also restricted us. We did not feel we would be able to obtain large quantities in lengths greater than 24 inches due to the occurrence of defects in the lumber. There were also some equipment restrictions. We were unable to produce any glued-up panels longer than 22 inches. Finally, we were limited by the board footage available. For planning purposes we assumed a yield of 25 to 33% of the gross footage, and chose our orders accordingly.

Based upon these restrictions, we chose to fill the orders listed in Table 17. These companies were contacted again to confirm the orders and to compile all their specifications as per color, quality, and surfacing.

Table 17. Dimension part orders to be filled.

				PRODUCT SPECS			
COMPANY	PRODUCT	SPECIES	QUAN.	THICK.	WIDTH	LENGTH	BD. FT
Cardinal Wood Products	Pieces	red maple	300	5/16	1 7/8	13	25
Cardinal Wood Products	Pieces	red maple	200	5/16	1 7/8	17	22
Cardinal Wood Products	Pieces	red maple	100	5/16	1 7/8	31	20
Carrier Furniture	Panels	red maple	100	3/4	12 1/2	12	104
Carrier Furniture	Panels	red maple	100	3/4	14	15	146
Carrier Furniture	Panels	red maple	100	3/4	16	17	188
Carrier Furniture	Panels	red maple	100	3/4	18	18	225
Carrier Furniture	Panels	red maple	100	3/4	17	19	224
Carrier Furniture	Panels	red maple	100	3/4	13	19	172
Carrier Furniture	Panels	red maple	100	3/4	21	21	306
Carrier Furniture	Panels	red maple	100	3/4	17	22	260
Carrier Furniture	Panels	red maple	20	3/4	21	25	73
Carrier Furniture	Panels	red maple	20	3/4	18	28	70
Carrier Furniture	Panels	red maple	20	3/4	12	28	47
Carrier Furniture	Panels	red maple	20	3/4	18	30	75
Carrier Furniture	Panels	red maple	20	3/4	18	35	87
Dana Robes Woodcraftsmen, Inc.	Pieces	red maple	200	7/8	3	32	133
Jim Kephart Woodturning	Turning Squares	red maple	100	3 1/2	3 1/2	21	204
Jim Kephart Woodturning	Turning Squares	red maple	100	4 1/4	4 1/4	21	310
Sargent Wood Products	Blanks	red maple	50	15/16	2 3/4	21	20
Sargent Wood Products	Blanks	red maple	50	15/16	2 1/2	22	19
Sargent Wood Products	Blanks	red maple	50	15/16	2 1/8	26 1/2	20
Sargent Wood Products	Blanks	red maple	50	15/16	2 3/4	30	29

Valley Woodworks	Panels	red maple	20	25/32	8 1/2	18	21
Valley Woodworks	Panels	red maple	20	25/32	9 1/2	18	24
Valley Woodworks	Panels	red maple	20	25/32	10 1/4	18	26
Anderson Woodturning	Turning Squares	red oak	2000	1	1	28 1/2	495
Aristokraft, Inc.	Frame Rail	red oak	210	1	1 3/4	29	92
Aristokraft, Inc.	Frame Stile	red oak	240	1	1 3/4	31	112
Aristokraft, Inc.	Frame Stile	red oak	340	1	1 3/4	32	165
Aristokraft, Inc.	Frame Rail	red oak	210	1	1 3/4	35	111
Aristokraft, Inc.	Frame Mullion	red oak	290	1	3 1/4	18	147
Aristokraft, Inc.	Frame Mullion	red oak	250	1	3 1/4	23	162
Aristokraft, Inc.	Frame Mullion	red oak	220	1	3 1/4	29	180
Aristokraft, Inc.	Frame Filler	red oak	240	1	3 1/4	32	216
Aristokraft, Inc.	Drawer Front	red oak	36	1	5 3/4	14	25
Aristokraft, Inc.	Drawer Front	red oak	80	1	5 3/4	17	67
Aristokraft, Inc.	Drawer Front	red oak	24	1	5 3/4	20	24
Aristokraft, Inc.	Drawer Front	red oak	48	1	5 3/4	23	55
Aristokraft, Inc.	Drawer Front	red oak	2	1	5 3/4	29	3
Aristokraft, Inc.	Drawer Front	red oak	10	1	5 3/4	33	16
Moot Wood Turnings	Turning Squares	red oak	200	1	1	13	22
Moot Wood Turnings	Turning Squares	red oak	200	1	1	25	44
	Strip Flooring	red oak	1216*	3/4	2 1/4	varies	1,621

* - square feet of select grade red oak strip flooring.

The majority of the products were produced at Sargent's Wood Products, Inc. in Gardner. Sargent's specializes in wood products and furniture component manufacturing. They have a fully modernized 25,000 square foot facility with state of the art machinery. They have the capacity to do a wide variety of machining on wooden components, including CNC routing, shaping, tenoning/mortising, sanding, assembly, and boring/dovetailing.

Sargent's produced all but two of our products. They did not have the proper glue clamp to do the 3 1/2" and 4 1/4" squares requested by Jim Kephart Woodturning, so Sargent cut the blanks and a furniture company (Eustis Chair of S. Ashburnham, MA) glued them up into squares. We also found that the thickness of the red oak pallet lumber was too variable to provide good yields of the 1" products. We therefore decided to add strip flooring to our product mix and contracted with Forester Moulding of Leominster, MA to mill the flooring. All of our production facilities tracked their time, costs, and yields.

The finished products were shipped to the companies that had ordered them. We followed this up with the mailing of a questionnaire (Appendix H). After the questionnaires were returned we conducted a follow-up phone interview to answer any remaining questions.

2. Raw materials acquisition

The kiln dried red oak and red maple pallet lumber was purchased for $250/MBF. . The market value for these materials is higher, at approximately $450/MBF for the maple ($200 for the lumber, $250 for the kiln drying), and $500/MBF for the oak ($200 for the lumber and $300 for the kiln drying). The red oak logs were purchased for $200/MBF, and the red maple logs were purchased for $100/MBF, both prices at the landing. It cost an additional $30/MBF for trucking from the landing to the mill.

These prices were consistent with our earlier research. These costs could possibly be lowered if the manufacturing facility was integrated into a sawmill operation so that the pallet lumber was used in-house. If the operation has the ability to sell firewood or pulp, and is part of a sawmill operation, it may be possible to cut costs by purchasing large quantities of the logs and sorting them at the mill for their highest and best use.

If this process were a part of a business, yields could be improved by instituting some simple grading or sorting rules. For the logs sweep and crook standards should be set. Logs could also be sorted by the number and spacing of visible defects as well as diameter. An additional sort of the pallet lumber on the green chain could greatly increase the average quality of the wood. Any of these practices would also most likely increase the cost of the materials.

Table 18. Cost of raw materials.

Item	Volume (Bd. Ft.)	Unit Price ($/MBF)	Total Cost
Red oak pallet lumber	3305	250	$826.25
Red maple pallet lumber	4025	250	$1006.25
Red oak logs	5445	230	$1252.35
Red maple logs	4555	130	$592.15

3. Primary Manufacturing

Our milling costs were $.20/BF. Our drying costs were $.25/BF for the red maple and $.30/BF for the red oak. These were in line with expected costs.

In the milling operation the sawyer chose the best face, cut one or two boards, flipped the log 180 degrees, and squared off the opposite face. The two-sided cant then went through a gang resaw. Edging and trimming was kept at a minimum.

This resulted in considerable overrun. The yield in red oak lumber was 6710 board feet (123%). The yield in red maple lumber was 6310 board feet (139%). There are several reasons for such a high overrun. First, The International ¼ - inch log rule underestimates the volume in small logs. The 123% overrun in the oak logs represents less than four additional feet per log, while the 139% overrun for the red maple logs represents almost ten additional feet per log. The logs were milled on a band mill, we used a small opening face, and there was little to no edging or trimming of the material. Finally, the final tally of the lumber was a gross tally of bundles of stacked lumber. Because of the character of the lumber there were a large number of round-edged, waney, and short pieces in each bundle, resulting in a slightly exaggerated tally.

The proper method of drying the lumber was the subject of debate throughout the project. Our options were to either dry the lumber, or dry the finished pieces. We have observed and read of the matter being handled both ways. When the whole boards are dried then kiln space and time is used to dry wood (maybe up to 70% of it) that will only be a waste material. If we only dried the parts we would have had to ship a lot of excess water, twice (the sawmill/dry kiln is fifteen miles from the manufacturing site). Handling the smaller material would also have been more costly, and there would have been a need to acquire special racks for drying the material. For the purposes of this study we decided that it would be appropriate and more efficient to dry the lumber first.

Table 19. Cost of primary processing.

Item	Volume	Unit Cost	Total Cost
milling red oak logs	5445	$0.20	$1089.00
milling red maple logs	4555	$0.20	$911.00
drying r.o. pallet lumber	3305	$0.30	$991.50
drying r.m. pallet	4025	$0.25	$1006.25

lumber			
drying r.o. log lumber	6710	$0.30	$2013.00
drying r.m. log lumber	6310	$0.25	$1577.50

4. Secondary production

Sargent's Wood Products produced the following products:

<u>red maple pieces</u> <u>red maple panels</u> <u>red oak turning squares</u> <u>red oak pieces</u>
Cardinal Wood Prod. Carrier Furniture Anderson Woodturning Aristokraft*
Dana Robes Woodcrft. Valley Woodworks Moot Wood Turnings Sargent Wood Prod.
J. Kephart Wood Turning**

* We utilized the standard Aristokraft order to provide the saw operators with several more choices when breaking down the red oak boards, but we did not intend to fill or ship a complete order for these products.

** Kephart's order was for 3 1/2" and 4 1/4" turning squares. Sargent's cut the component pieces for these squares but was unable to glue-up the squares. This work was done by Eustis Chair.

Sargent Wood Products is a small (fifteen employee) furniture component subcontractor located in Gardner, MA. We selected them to do the majority of the production because they were local and they had the ability and willingness to do the work. However, Sargent's is not set up for high efficiency millwork and low grade wood processing. A high efficiency mill would have utilized equipment and processes such as gang ripping, plane first, an optimizing set-up, better handling equipment, and re-use of waste products, etc.

The following methods were used for the purpose of costing during the course of this project:

1. Lumber was handled on a chop first basis
2. It was then surfaced both sides
3. It was ripped one edge at a time
4. Panels were matched, glued, and planed
5. Squares were resurfaced on edge.

Production occurred between the months of August and November, 2001. We had originally intended to track the yields from the red maple pallet lumber separately from the red maple log lumber. Unfortunately, during production these sources were mixed, so we were unable to determine which source was used for which product. The two sources of lumber were therefore added together for the purpose of calculating yield.

At the beginning of the production period Sargent's, like many other wood companies at that time, was experiencing a slow down in orders. At the end of the summer, however, this changed and the shop became very busy. Our orders were therefore done as time allowed. When production was halted at the end of November due to the time constraints of the grants, we had completed and shipped most of the orders.

The only orders left unfinished were a few of the Carrier Furniture panels. We did not complete the Aristokraft order as planned, but, as mentioned before, that order was used only to provide the saw operator with a number of choices. During production Sargent decided that they could also utilize red oak parts for their products (upholstered furniture frames), so they added an additional part to the mix.

Tables 20 through 29 provide a summary for each of the individual orders. Each table lists the company placing the order, the species used, and the individual product dimensions. For each individual product we list the number actually produced, the production cost per unit, the total cost, the board feet per part, the total board feet, the unit value and the total value. At the bottom of each table we summarize the total cost, total board feet, and total value.

The production costs are strictly Sargent's costs for producing the product. It does not include the cost of the material. It should be noted that this is their contract rate. The actual cost of production would be somewhat lower if we had been able to produce the parts "in-house".

The board foot content for the parts was calculated using the full one-inch thickness for products made from the red maple lumber and the red oak pallet lumber, and a 5/4 thickness for the products produced from the red oak "log" lumber. For the Cardinal Wood Products order we assumed a 1/2 inch thickness for each piece (two pieces per board) for the purposes of calculating board foot content.

The product values were provided by the end-users. For the mock Aristokraft order we used a value of $180 per board foot. Aristokraft pays from $1.60 to $2.00 per board foot for this material, based upon yield. We chose an average value of $1.80 for our parts. Table 30 lists the unit vale as $1.44/bd. Ft. because Aristokraft bases their board foot tally on 1-inch stock while our board footage, for the purpose of consistency in measuring yield, was calculated using 5/4 inch stock. The $1.44/bd. Ft. figure based upon our measurement yields the same total value as $1.80 per board foot based upon their measure.

5. Red Oak strip flooring

The red oak flooring was produced at Forester Moulding in Leominster, MA. Forester produces flooring, but usually of wider widths than our strip flooring. They also were not accustomed to using low grade material. Forester usually produces product at a rate of 1,000 linear feet per hour (regardless of width). The operation requires four people, two on the ripping operation, and two on the moulder. Rates used for billing our order were based on this production rate and their normal shop rate. This rate includes an amount to cover direct labor cost, labor related costs, shop overhead, and a contribution to profit.

Our lumber was first ripped to width, and then run through the moulder to produce the flooring. The pieces were not end matched. Forester does not have the necessary equipment to defect strip flooring (In an efficient operation the defecting would have been done by an optimizing saw). The flooring was therefore returned to us at full length. We estimated the amount of defecting that would be needed and used Forester's shop rate to calculate the cost of defecting.

Using National Oak Flooring Manufacturers Association grading rules, we defected the flooring with a crayon to meet the Select Oak grade. This grade may contain unlimited sound sapwood; slight imperfections in milling; a small tight knot every three feet ; pin worm holes; burls; and a reasonable amount of slightly open checks.

Using a minimum acceptable length of fifteen inches (1.25 ft.) we tallied the total amount of useable flooring that met the select grade. Starting with 3,305 board feet of lumber (the equivalent of 3,305 square feet) we ended up with 1216 square feet of flooring, a yield of 37 percent.

Forester normally uses FAS or Select and Better red oak for their production. Even with these grades they experience up to a 40 percent loss. The yield loss usually consists of visually defective lumber culled out from the shipment, which usually constitutes an eight to ten percent loss. Another 20 percent is lost in ripping mostly because the input widths do not translate precisely into the desired output widths and some thin strips result that cannot be used. Finally, in the moulding operation another ten to twelve percent is lost, adding up to a total loss of 40 percent.

Forester usually works with lumber that is skip-planed to provide a visible surface. We provided them with rough lumber, which made it difficult to assess the quality of the faces. This resulted in several pieces where the poor face was up, resulting in a loss of potential yield.

Table 20. Cardinal Wood Products order.

Company	Cardinal Wood Products	# Produced	Unit Cost	Total Cost	Bd. Ft. /part	Total Bd. Ft	Unit Value	Total Value
Product	pieces							
Species	red maple							
Dimensions	5/16x1 7/8x13	335	$0.55	$184.25	.0846	28.34	$0.35	$117.25
	5/16x1 7/8x17	214	0.56	119.84	.1107	23.69	0.45	96.30
	5/16x1 7/8x31	110	0.62	68.20	.2018	22.20	0.83	91.30
Total board feet						74.23		
Total Costs & Value				$372.29				$304.85

Table 21. Carrier Furniture order.

Company	Carrier Furniture	# Produced	Unit Cost	Total Cost	Bd. Ft./part	Total Bd. Ft	Unit Value	Total Value
Product	Panels							
Species	red maple							
Dimensions	3/4x12 1/2x12	100	1.75	$175.00	1.04	104.00	$3.57	$357.00
	3/4x14x15	100	1.90	190.00	1.46	146.00	4.57	457.00
	3/4x18x18	100	2.50	250.00	2.25	225.00	7.05	705.00
	3/4x17x19	101	2.50	252.50	2.24	226.24	7.03	710.03
	3/4x13x19	101	2.50	252.50	1.72	173.72	5.37	542.37
	3/4x21x21	100	2.50	250.00	3.06	306.00	9.59	959.00
	3/4x17x22	100	2.50	250.00	2.60	260.00	8.13	813.00
	3/4x19x25	19	2.75	52.25	3.30	62.70	10.42	197.98
	3/4x18x28	40	2.90	116.00	3.50	140.00	10.75	430.00
	3/4x12x28	40	2.35	94.00	2.33	93.20	7.31	292.40
	3/4x18x30	21	3.10	65.10	3.75	78.75	11.75	246.75
	3/4x18x35	20	3.60	72.00	4.38	87.60	13.70	274.00
	3/4x 22 1/2 x35	12	4.05	48.60	5.47	65.64	17.13	205.56
Total board feet						1968.85		
Total Costs & Value				$2067.95				$6190.09

Table 22. Dana Robes Woodcraftsmen order.

Company	Dana Robes	# Produced	Unit Cost	Total Cost	Bd. Ft./part	Total Bd. Ft	Unit Value	Total Value
Product	pieces							
Species	red maple							
Dimensions	7/8 x 3 x 32	200	$0.37	$74.0	0.667	133.3	$3.10	$620.0

				0		3		0
Total board feet						133.33		
Total Costs & Value				$74.00				$620.00

Table 23. Sargent Wood Products order.

Company	Sargent Wood Products	# Produced	Unit Cost	Total Cost	Bd. Ft./part	Total Bd. Ft	Unit Value	Total Value
Product	pieces							
Species	red maple							
	average piece	1750	$0.55	$962.50	0.5	875	$1.10	$1925.00
Total board feet						875		
Total Costs & Value				$962.50				$1925.00

Table 24. J. Kephart Woodturning order.

Company	J. Kephart Woodturning	# Produced	Unit Cost	Total Cost	Bd. Ft./part	Total Bd. Ft	Unit Value	Total Value
Product	Turning squares							
Species	red maple							
Dimensions*	3 1/2 x 3 1/2 x 21	103	4.03	414.76	2.10	216.2	$8.00	$824.00
	4 1/4 x 4 1/4 x 21	103	5.18	533.60	3.19	328.6	9.00	927.00
Total board feet						544.8		
Total Costs & Value				$948.36				$1751.00

* - produced in two steps; Sargent W.P. produced pieces on a per piece rate ($0.49 & $0.52). Eustis glued up on an hourly rate ($30/hr., 15.5 hours)

Table 25. Valley Woodworks order.

Company	Valley Woodworks	# Produced	Unit Cost	Total Cost	Bd. Ft./part	Total Bd. Ft	Unit Value	Total Value
Product	panels							
Species	red maple							
Dimensions	25/32 x 8 1/2 x 18	20	$1.95	$39.00	1.06	21.2	$2.40	$48.00
	25/32 x 9 1/2 x 18	20	2.00	40.00	1.19	23.8	2.70	54.00
	25/32 x 10 1/4 x 18	20	2.15	43.00	1.28	25.6	3.00	60.00
Total board feet						70.6		
Total Costs & Value				$122.00				$162.00

Table 26. Anderson Woodturning order.

Company	Anderson Wood Turning	# Produced	Unit Cost	Total Cost	Bd. Ft./part	Total Bd. Ft	Unit Value	Total Value
Product	Turning squares							
Species	red oak							
Dimensions	1 x 1 x 28 1/2	5250	$0.44	$2310.00	0.25	1298.83	$0.65	$3412.50
Total board feet						1298.83		
Total Costs & Value				$2310.00				

Table 27. Moot Woodturning order.

Company	Moot Woodturnings	# Produced	Unit Cost	Total Cost	Bd. Ft./part	Total Bd. Ft	Unit Value	Total Value
Product	turning squares							
Species	red oak							
Dimensions	1 x 1 x 13	246	$0.37	$91.02	0.113	27.80	$0.13	$31.98
	1 x 1 x 25	202	0.42	84.84	0.217	43.84	$0.25	$50.50
Total board feet						71.64		
Total Costs & Value				$175.86				$82.48

Table 28. Sargent Wood Products order.

Company	Sargent Wood Products	# Produced	Unit Cost	Total Cost	Bd. Ft./part	Total Bd. Ft	Unit Value	Total Value
Product	pieces							
Species	red oak							
	ave. piece	590	$0.55	$324.50	0.5	295	$1.10	$649.00
Total board feet						295		
Total Costs & Values				$324.50				$649.00

Table 29. Red oak strip flooring order.

Company		# Produced	Unit Cost	Total Cost	Bd. Ft./part	Total Bd. Ft	Unit Value	Total Value
Product	strip flooring							
Species	red oak							
Dimensions	3/4 x 2 1/4 x 12	1216	$1.70	$2069.30	1.33	1625	$2.23	$2711.68
	defecting		$0.22	265.14				
Total board feet						1625		
Total Costs				$2334.44				$2711.68

Table 30. Aristokraft order.

Company	Aristokraft	# Produced	Unit Cost	Total Cost	Bd. Ft./part	Total Bd. Ft	Unit Value*	Total Value
Product	pieces							
Species	red oak							
Dimensions	1 x 1 3/4 x 29	336	$0.44	$147.84	.44	147.84	$1.44	$212.89
	1 x 3 1/4 x 18	182	0.41	74.62	.51	92.82	1.44	133.66
	1 x 3 1/4 x 23	244	0.51	124.44	.65	158.60	1.44	228.38
	1 x 3 1/4 x 29	228	0.65	148.20	.82	186.96	1.44	269.22
	1 x 3 1/4 x 32	240	0.72	172.80	.90	216.00	1.44	311.04
	1 x 3 1/4 x 35	161	0.78	125.58	.99	159.39	1.44	229.52
Total board feet						961.61		
Total Costs				$793.48				$1384.71

*per board foot.

Tables 31, 32, and 33 provide a summary of all red maple, red oak, and flooring orders, respectively. For each of those categories the tables show the totals of all production costs, board feet used, and product values. At the end of production a tally was taken of all unused lumber and this was subtracted from the beginning tally to determine the full amount used in production. The yield for each category is the amount of board feet used in the products as a percentage of the total board feet consumed. The total cost figures are the sum of the production costs and the value of the lumber consumed.

Our yield for the red maple lumber was 43.7 %. This far exceeds the expected yield or that reported by other sources. The yield from the red oak "log" lumber was 41.8%. The red oak pallet lumber yielded 37% in strip flooring.

Taken in total, the red maple products cost $4,547.10 to produce. The cost of the lumber was $4,133.20. The value of the products produced was $10,952.94. Costs exceeded revenue for these products by $2,272.64.

The red oak products cost $3,603.84 to produce. The value of the lumber used was $4,077.23. The products produced were valued at $5,528.69. Costs exceeded revenues by $2,152.38.

The red oak strip flooring was produced at a cost of $2,334.44. The lumber used cost $1,817.75. The wholesale value of the flooring was $2,711.68. The cost exceeded the revenue by $1,440.51.

Table 31. Red maple production.

Beginning inventory:	Volume (Bd. Ft.)	$/MBF	Cost
Pallet lumber	4025	500.00	2012.50
Lumber from logs	6310	488.22	3080.65
All lumber	10335	492.81	5093.15
unused lumber	1948		

lumber used in production	8387	492.81	4133.20
Customer	Production Costs	Bd. Ft. used	Product Value
Cardinal	$372.29	74.23	$ 304.85
Carrier	2067.95	1968.85	6190.09
Dana Robes	74.00	133.33	620.00
Jim Kephart	948.36	544.84	1751.00
Sargents	962.50	875.0	1925.00
Valley	122.00	70.6	162.00
Totals	$4547.10	3666.85	$10952.94
Lumber yield	43.7 %		
	Total Cost	Total Income	Profit
	$8680.30	$10952.94	$2272.64

Table 32. Red oak production, lumber from logs.

Beginning inventory:	Volume (Bd. Ft.)	$/MBF	Cost
Lumber from logs	6710	648.93	4354.35
unused lumber	427		
lumber used in production	6283	648.93	4077.23
Customer	Production Costs	Bd. Ft. used	Product Value
Moot	175.86	71.64	82.48
Anderson	2310.00	1298.83	3412.50
Aristokraft	793.48	961.61	1384.71
Sargent	324.50	295.00	649.00
Totals	$3603.84	2627.08	$5528.69
Lumber yield	41.8%		
	Total Cost	Total Income	Loss
	$7681.07	$5528.69	($2152.38)

Table 33. Red oak production, flooring from pallet lumber

Product: Red Oak Strip Flooring

Raw Material:	KD R.O. Pallet Lumber	3305 bd ft.	
	cost	$1,817.75	$550/MBF
undefected flooring	pieces	982	
	lineal ft.	8106	
	sq. ft.	1520	
defected flooring	pieces	2027	
	lineal ft.	6488	
	sq. ft.	1216	
	board feet	1622.00	
	value @ $2.23/sq. ft.*	2711.68	
	retail value @ $2.69/sq. ft.**	3271.04	
Costs:	ripping lumber @ $0.10/bd. Ft.	330.50	
	flooring production @ $0.20/lin. Ft.	1738.80	8694 lineal ft.
	defecting @ $0.22/sq. ft.	265.14	
	lumber @ $0.55/bd.ft.	1817.75	
	Total Costs	4152.19	

*Hardwood Market Report, Nov. 3, 2001		
Select Plain Red Oak 3/4" x 2 1/4" flooring	Began with	3305 sq. ft.
Appalachian area	undefected flooring	1520 sq ft. 46%
$1670/MBF or $2.23/sq. ft.FOB mill	defected flooring	1216 sq. ft. 37%
**Home Depot, 11/13/01. Phone call		

6. Kiln-drying

It is important to understand the effect that our decision to kiln-dry lumber rather than parts will have on the bottom line. Our decision was based more on convenience and feasibility than cost. To have dried parts we would have had to ship green lumber from the mill to the wood shop, and then green parts back again. The dry kiln also had no experience with drying parts.

This decision, however, did have a significant impact on the profitability of the different products (Section V.). We kiln dried 10,335 board feet of red maple lumber at a cost of $0.25 per board foot. Almost two thousand feet (1,948) of this lumber were not used in production. The $487.00 cost of drying this lumber was, however, included in the total production cost. In addition, we obtained a yield of 43.7% from the red maple. The 56.3% that was waste represents another $1,180 in drying costs (4,722 bd. Ft. @ $0.25). Similarly, $1,225.20 was spent in drying red oak wood that was not used (4084 bd. Ft. @ $0.30).

In all, if we remove the drying costs from the profitability analysis in Section V. and replace it with a cost of $0.25 per board foot (maple), or $0.30 per board foot (oak) for the total volume in finished pieces only we would reduce the overall drying costs from $5,588.25 to $2,069.44 for a savings of $3,518.81. This cost reduction improves the per unit and total profitability of each product. The total cost of product falls by $2,904.60, while the remaining $615.00 of savings is in the unused lumber inventory. Two additional products would show a product, and an additional twelve products would be ‘potentially profitable’, falling between -$0.03 and -$0.70 per board foot. This creates a rather ideal and overly optimistic picture of the drying cost reduction because the per board foot drying cost for parts would most certainly be higher than the lumber drying cost due to increased handling costs. Also, the parts would have to be cut slightly oversize to account for shrinkage, and there most likely would be some drying loss due to end-checking and other defects, which would require overruns of the parts to allow for the loss.

7. Follow-up.

After the products were produced and shipped we asked the end-users to complete a questionnaire (Appendix V). Table 34 shows the end-use of the various products produced during this project. The Dana Robes order deserves mention because it is a product specially designed for this project. They normally make the knife blocks (for holding kitchen knives) from cherry. They are interested in seeing how well their customers accept them.

Table 34. End-use of Wood Recovery Products.

Company	Species	Product	End-use
Cardinal Wood Prod.	red maple	parts	slats for store fixtures
Dana Robes Woodcrft.	red maple	parts	knife block
Sargent Wood Prod.	red maple & red oak	parts	upholstered furniture
J. Kephart Woodturning	red maple	turning squares	exercise pins
Carrier Furniture	red maple	panels	Shelves & dust panels - casegoods
Valley Woodworks	red maple	panels	Collapsible baskets
Anderson Woodturning	red oak	turning squares	Bed and chair spindles
Moot Wood Turning	red oak	turning squares	furniture spindles
Aristokraft	red oak	parts	cabinet drawers and doors

Three of the companies rated the product as average quality. Dana Robes commented that about 15% of the stock was unusable because of twisted stock and natural defects. Tighter specifications may have decreased this number. One, J. Kephart Woodturning, commented that the large turning squares are usually made with fewer plies (we had four and five), which means fewer glue lines to worry about. Valley Woodworks currently uses yellow birch for their product. They said that the red maple is usuable in their craft products, but that it has more defects than the materials they are used to.

Sargent and Carrier rated the products as above average. Sargent did note that worm holes present in the parts could weaken the hold on dowels. One customer reported no problems and rated the product as excellent (Anderson Woodturning).

Five out of eight responding companies customarily outsource the production of these products. We asked them what factors were important in choosing to outsource. The following factors were listed as being important in the decision on where or how to acquire these products: price (2), quality (2), on-time delivery (1), cost (1), convenience (1), and the size of the order (1). Table 35 lists the customary source and the annual demand for the product.

Table 35. Demand for Wood Recovery Products.

Company	Usual Source	Annual Use	Timing of Orders
Cardinal Wood Prod.	in-house	unknown	unknown
Dana Robes Woodcrft.	in-house	up to 600 parts	2-3 times/yr.
Sargent Wood Prod.	in-house	7,500 bd. Ft.	quarterly
J. Kephart Woodturning	outsource	minor	seldom
Carrier Furniture	outsource	3,000 panels	Every 8 weeks
Valley Woodworks	outsource	4,000 panels	4 times/yr.
Anderson Woodturning	outsource	5000 parts	2 times/yr.
Moot Wood Turning	outsource	20000 parts	3-4 times/yr.

Aristokraft	outsource	Unlimited	ongoing

It is interesting to note the wide range of prices paid by these companies (as shown in Tables 20 to 30), and the resulting profitability of our project (as discussed in Section V). For instance, the oak turning squares ordered by Anderson and Moot are essentially the same products, yet Anderson pays over twice as much for them as Moot. On the other hand, Moot uses four times as much of the product annually. Dana Robes also pays much more per unit than Aristokraft, but would use far less.

8. Summary and discussion

Between May and November, 2001, we manufactured several small wood products from low-quality source materials, utilizing the resources of several local businesses. As a business venture, our exercise was not very profitable, but it did provide us with a wealth of experience, and a good base on which to go further.

There were several limiting factors that influenced our end results, not the least of which was our inexperience with the production process. Another important factor was the inexperience of our contractors in dealing with low-quality material, and the fact that their shops were also not set up properly for this material. We were lacking the proper equipment to produce some of the parts, and for one part we had to utilize two separate shops.

We were also limited by the orders that we received. A larger cutting bill might have improved the yield. The value of the different products was also not factored into our production plans. We took the orders based upon their suitability to our source material rather than for their potential profit.

We had hoped to be able to make a comparison of the yields from the various source materials. However, we did not exert proper control over the red maple lumber and both pallet and log lumber became mixed during the production process. For the red oak, we were unable to make 1-inch parts from the pallet lumber because of its inconsistent width, so it was used to produce the flooring. The oak log lumber yielded about 40% in parts while the pallet lumber yielded 37% in flooring, but it is difficult to draw any conclusions from these figures. Visual observations at Sargent's did provide the impression that the pallet lumber was of better quality than the log lumber, but the difference was not great. Grading and sorting practices could be employed that improve the overall quality of each, too.

In retrospect we should have exercised more control over our inventories, and also applied an additional sort on both sources of lumber to discard the truly cull pieces and improve yield. In regards to the flooring, if we had made an attempt to provide only six-inch boards we would have greatly improved our yields. Instead we gave a straight run of pallet lumber that was from four to eight inches wide, which resulted in a considerable amount of waste.

Despite these shortcomings, we were able to produce acceptable parts for our customers. We also attained reasonable yield figures. Overall the cost of production exceeded the potential revenues, but there were individual products that would have shown a profit (these are discussed in more detail in the next section). It is our belief that it is possible to improve upon the methods we employed and increase the quality, yield, and the profitability of the process.

V. Business Plan

> "There is a difference between selling wood products, and marketing wood products. Most Massachusetts sawmills are engaged in selling their products. Marketing involves creating a consumer identity for specific products. Most small businesses do not have the resources or expertise to develop and execute a marketing plan." (Mater Report)

A. Introduction

An essential component of a business plan is an entrepreneur with an idea and a willingness to begin a new business. The entrepreneur would set the boundaries within which the business planner would operate. He or she would provide the essential data and make the necessary decisions relative to the characteristics of the business. Unfortunately, our project at this time lacks the entrepreneur who would be the driving force behind a new business. Lacking this force our business planner is without the necessary guidance, or boundaries, that are needed to form a proper plan.

We also learned along the way that the methods we employed to produce our products are not necessarily those that a dimension shop utilizing low-valued materials would employ. We had to subcontract the production to facilities that were not used to handling the material and did not necessarily have the proper equipment. We also had to deal with our own inexperience, which led to several missteps along the way.

Although we have learned and have acquired some valuable information, we are not in a position at this time to produce a full-fledged business plan. We can, however, provide the following analysis.

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B. Cost and Profitability Calculations

Lumber costs for the red maple and red oak logs and pallet materials used in the production of dimension parts and panels are summarized in Table 36, *Cost of Lumber*, and Table 37, *Summary of Lumber Costs Placed in Production.* The costs include the cost of logs delivered to the mill, the cost of milling the logs into boards, and the cost of kiln drying the lumber to specifications. For the pallet materials, the cost assigned to the material is the current market value of green pallet lumber (essentially a commodity with a well established and known price) at the mill. This is the opportunity cost of the pallet material to the mill owner; it is the value given up by committing the material to a different use. It becomes the relevant decision-making cost for the pallet material; whatever log and milling costs that might be assigned to the pallet material by the accounting system are not relevant at this decision point on how to use the green pallet material. Kiln drying costs are necessary and therefore relevant to determining the cost of the material when used in the further processing done in this project.

Table 36 shows the calculation of unit costs for each of the four source materials used in the demonstration project. Red maple pallet material and red maple boards milled from low-grade maple logs ended up with nearly identical unit costs ($0.49 per board foot for milled logs and $0.50 for the pallet material). Boards milled from low-grade red oak logs were significantly more costly at $0.65 per board foot than the red oak pallet material at $0.55. Since the subcontractors doing the secondary processing for the project reported that the pallet material and boards milled from low-grade logs were essentially the same in quality and workability, the economic viability of milling low-grade logs is raised to question.

However, we have observed other mills that have been successful in processing low-grade hardwood logs directly into dimension stock. One such mill, Hull Forest Products of Pomfert, Connecticut, devotes about 50% of its annual capacity to the production of dimension pieces directly from low-grade logs. Their integrated operation includes special, computer-assisted cutting protocols at the breakdown saw, on-site kiln drying, and high speed-high volume computer optimized defecting of the kiln dried boards into dimension stock orders.

Table 36 also shows the percentage breakdown of costs between acquisition, milling and kiln drying. Note that kiln drying is the largest component, ranging from 46% for red oak logs to 55% for red oak pallet material. This high cost of drying underscores the concern over the issue of *when* to dry. Since production yields (Table 37) ranged from 29.5% for the red maple to 41.8% for the red oak, a significant portion of these drying costs are for material that ends up as unusable. The yield calculations are given in Table 37. They are computed by dividing the material content (board feet) in the finished product by the amount of material entered into the secondary processing

Table 38, *Unit Cost and Profitability Analysis*, evaluates all the orders received and filled during the wood recovery demonstration project in terms of unit cost and unit profitability. For each product, we identify the species of material (red maple or red oak). For red maple products the source material, consisting of red maple pallet lumber and boards milled from low-grade red maple logs, were commingled in the processing stage and cannot be accurately traced into specific red maple orders processed. The red oak products, with the exception of the strip flooring, were all produced from the lumber milled from low-grade red oak logs. The strip flooring was all produced using the red oak pallet lumber.

The “Product” column identifies the type of product processed. “Parts” are solid dimension pieces, finished to customer specifications for secondary wood product manufacturers such as furniture companies, who use the parts in their production process, usually with some further processing, in the assembly of final products. Turning squares are similar to “parts” in terms of processing requirements, differing primarily in destined end use. Panels consist of edge-glued smaller pieces combined to fill the dimension requirements. The pieces are produced in much the same way as “parts”; the gluing and finishing of the panels represent additional manufacturing steps adding value to the material. Glued turning squares consist of face-glued dimension pieces. Strip flooring is the familiar tongue-in-groove hardwood flooring material sold by the lineal foot.

The “Dimensions” column shows the finish dimensions for each product. These dimensions are used to compute the material content (column labeled “Board Feet”) in a unit of the finished product. In making this computation, we have followed the convention of basing material content on surface square feet rather than board feet, since all of the products we produced from 1-inch stock. The glued turning square calculations reflect the number of pieces in each square.

Following the “Customer” column, which is self-explanatory, are 4 columns relating to the cost of the product. The first three show the calculation of material (lumber) cost, while the fourth shows the processing cost. The material “Yield” column shows the ratio of the material content in the finished products to the board feet of material input consumed in the production process. Due to commingling of materials and orders, we were not able to compute yields by individual order. Nor were we able to distinguish yields from red maple between that from pallet lumber and that milled from low-grade logs. We were able to distinguish yields of red oak pallet lumber from lumber milled from low-grade red oak logs. Yield calculations are shown in Table 37, *Summary of Lumber Costs Placed in Production.*

Material “Quantity” represents the estimated input material needed per unit of finished product. It is determined by dividing the material content in the finished product (“Board Feet”) by the “Yield”. The product’s material “Unit Cost” is then computed by multiplying the “lumber cost per board foot” (see Table 36, *Cost of Lumber*.) Total lumber costs, split between unused lumber and lumber placed into production, and the yield calculations are shown in Table 37, *Summary of Lumber Costs Placed in Production.*

Processing costs represent the total processing costs billed by the subcontractors for the order expressed as a per unit charge. These rates reflected the subcontractors' normal factory billing rates. This means they are designed to cover shop labor, overhead and make a contribution to profit. They are, therefore, presumably greater than the manufacturing cost of the products to the producer.

The products are next evaluated for profitability, first on a "Per Unit" basis, and then on a "Per Board Foot" basis. Profitability is computed by the formula, Value – Cost = Profitability. The value or price per unit of finished product has, in almost all cases, been obtained from the customer in response to a questionnaire and follow-up phone call after the goods were delivered. In most cases, value was the price paid to the customer's normal outside supplier for the item. In other instances, value was estimated because the part had previously been produced internally or was new to the customer. The "Cost" computation has already been explained. "Per Bd. FT." figures are computed by dividing the per unit figures by the board foot measure of the finished product.

The profitability measure is not an accurate measure of "true" profitability for several reasons, some of which have already been alluded to above. All of the data used in the computations are anecdotal and based on single cases or very small samples; so all inferences drawn from the analysis have no statistical validity. However, the profitability measure does provide a rational basis for ranking and evaluating the various orders in terms of "relative profit potential."

Table 36. Cost of lumber input to secondary processing
(excludes transportation from mill to secondary processor)

Cost Element	Red Oak Pallet		Red Oak Logs		Red Maple Pallet		Red Maple Logs		GRAND TOTALS	
	Cost	%	Cost	%	Cost	%	Cost	%	Cost	%
Purchase Price of Marerial at mill	$ 826.25	45%	$ 1,252.35	29%	$ 1,006.25	50%	$ 592.15	19%	$ 3,677.00	33%
Milling cost			$ 1,089.00	25%			$ 911.00	30%	$ 2,000.00	18%
Kiln Drying Cost	$ 991.50	55%	$ 2,013.00	46%	$ 1,006.25	50%	$ 1,577.50	51%	$ 5,588.25	50%
Total Cost at Mill	**$ 1,817.75**	100%	**$ 4,354.35**	100%	**$ 2,012.50**	100%	**$ 3,080.65**	100%	**$ 11,265.25**	100%
Lumber volume in board feet	3,305		6,710		4,025		6,310		20,350	
Lumber cost per board foot	**$ 0.55**		**$ 0.65**		**$ 0.50**		**$ 0.49**		**$ 0.55**	

Table 37. Summary of Lumber Costs Related to Production

	Red Oak Pallet		Red Oak Logs		Red Maple Combined		GRAND TOTALS	
Physical Quantities	Board Feet	%	Board Feet	%	Board Feet	%	Board Feet	%
Total Board Feet	**3,305**	**100%**	**6,710**	**100%**	**10,335**	**100%**	**20,350**	100%
Not Used	**-**	**0%**	**427**	**6%**	**1,948**	**19%**	**2,375**	12%
To Production	**3,305**	**100%**	**6,283**	**94%**	**8,387**	**81%**	**17,975**	88%
Board Feet in Finished Product	**1,216**		**2,627**		**3,667**		**7,510**	
Yield	**36.8%**		**41.8%**		**43.7%**			
Costs	Cost	%	Cost	%	Cost	%	Cost	%
Total Cost	**$ 1,817.50**	**100%**	**$ 4,354.35**	**100%**	**$ 5,102.15**	**100%**	**$ 11,274.00**	100%
Assigned to unused lumber	**$ -**	**0%**	**$ 277.10**	**6%**	**$ 961.68**	**19%**	**$ 1,238.78**	11%
Assigned to Production	**$ 1,817.50**	**100%**	**$ 4,077.26**	**94%**	**$ 4,140.47**	**81%**	**$ 10,035.22**	89%
Total from Profitability Analysis	**$ 1,817.39**		**$ 4,077.37**		**$ 4,136.59**		**$ 10,031.35**	
Assignment Accuracy	**99.99%**		**100.00%**		**99.91%**		**99.96%**	

Wood Recovery Project: Unit cost and profitability analysis
Ranked in Descending order of profitability measure per board foot.

Product Description					Manufacturing Costs					Profitability Analysis					
					Material			Processing	Total	Per Unit Profitability			Per Bd. Ft. Profitability		
Species	Product	Dimensions	Board Feet	Customer	Yield	Quantity	Unit Cost	Cost	Cost	Value	Cost	Profitability	Value	Cost	Profitability
Red Maple	Part	7/8x3x32	0.667	Dana Robes	0.437	1.526	$ 0.75	$ 0.37	$ 1.12	$ 3.10	$ 1.12	$ 1.98	$ 4.65	$ 1.68	$ 2.97
Red Maple	Panel	3/4x35x22 1/2	5.469	Carrier	0.437	12.51	$ 6.17	$ 4.05	$ 10.22	$ 17.13	$10.22	$ 6.91	$ 3.13	$ 1.87	$ 1.26
Red Maple	Panel	3/4x25x19	3.299	Carrier	0.437	7.548	$ 3.72	$ 2.75	$ 6.47	$ 10.42	$ 6.47	$ 3.95	$ 3.16	$ 1.96	$ 1.20
Red Maple	Panel	3/4x21x21	3.063	Carrier	0.437	7.008	$ 3.45	$ 2.50	$ 5.95	$ 9.59	$ 5.95	$ 3.64	$ 3.13	$ 1.94	$ 1.19
Red Maple	Panel	3/4x35x18	4.375	Carrier	0.437	10.011	$ 4.94	$ 3.60	$ 8.54	$ 13.70	$ 8.54	$ 5.16	$ 3.13	$ 1.95	$ 1.18
Red Maple	Panel	3/4x30x18	3.750	Carrier	0.437	8.581	$ 4.23	$ 3.10	$ 7.33	$ 11.75	$ 7.33	$ 4.42	$ 3.13	$ 1.95	$ 1.18
Red Maple	Panel	3/4x28x18	3.500	Carrier	0.437	8.009	$ 3.95	$ 2.90	$ 6.85	$ 10.75	$ 6.85	$ 3.90	$ 3.07	$ 1.96	$ 1.11
Red Maple	Panel	3/4x17x22	2.597	Carrier	0.437	5.943	$ 2.93	$ 2.50	$ 5.43	$ 8.13	$ 5.43	$ 2.70	$ 3.13	$ 2.09	$ 1.04
Red Maple	Panel	3/4x28x12	2.333	Carrier	0.437	5.339	$ 2.63	$ 2.35	$ 4.98	$ 7.31	$ 4.98	$ 2.33	$ 3.13	$ 2.14	$ 1.00
Red Maple	Panel	3/4x18x18	2.250	Carrier	0.437	5.149	$ 2.54	$ 2.50	$ 5.04	$ 7.05	$ 5.04	$ 2.01	$ 3.13	$ 2.24	$ 0.89
Red Maple	Panel	3/4x17x19	2.243	Carrier	0.437	5.133	$ 2.53	$ 2.50	$ 5.03	$ 7.03	$ 5.03	$ 2.00	$ 3.13	$ 2.24	$ 0.89
Red Maple	Glued Turning Sq	3 1/2x3 1/2x21	2.101	Kephart	0.437	4.808	$ 2.37	$ 4.03	$ 6.40	$ 8.00	$ 6.40	$ 1.60	$ 3.81	$ 3.04	$ 0.76
Red Maple	Panel	3/4x14x15	1.458	Carrier	0.437	3.337	$ 1.65	$ 1.90	$ 3.55	$ 4.57	$ 3.55	$ 1.02	$ 3.13	$ 2.43	$ 0.70
Red Maple	Panel	3/4x12 1/2x12	1.042	Carrier	0.437	2.384	$ 1.18	$ 1.75	$ 2.93	$ 3.57	$ 2.93	$ 0.64	$ 3.43	$ 2.81	$ 0.62
Red Maple	Panel	3/4x13x19	1.715	Carrier	0.437	3.925	$ 1.94	$ 2.50	$ 4.44	$ 5.37	$ 4.44	$ 0.93	$ 3.13	$ 2.59	$ 0.55
Red Maple	Glued Turning Sq	4 1/4x4 1/4x21	3.189	Kephart	0.437	7.297	$ 3.60	$ 5.18	$ 8.78	$ 9.00	$ 8.78	$ 0.22	$ 2.82	$ 2.75	$ 0.07
Red Maple	Part	average piece	0.500	Sargent	0.437	1.144	$ 0.56	$ 0.55	$ 1.11	$ 1.10	$ 1.11	$ (0.01)	$ 2.20	$ 2.23	$ (0.03)
Red Maple	Part	5/16x1 7/8x31	0.202	Cardinal	0.437	0.462	$ 0.23	$ 0.62	$ 0.85	$ 0.83	$ 0.85	$ (0.02)	$ 4.11	$ 4.20	$ (0.09)
Red Oak	Part	average piece	0.500	Sargent	0.418	1.196	$ 0.78	$ 0.55	$ 1.33	$ 1.10	$ 1.33	$ (0.23)	$ 2.20	$ 2.65	$ (0.45)
Red Maple	Panel	25/32x10 1/4x18	1.281	Valley Woodworks	0.437	2.932	$ 1.45	$ 2.15	$ 3.60	$ 3.00	$ 3.60	$ (0.60)	$ 2.34	$ 2.81	$ (0.46)
Red Maple	Panel	25/32x9 1/2x18	1.188	Valley Woodworks	0.437	2.717	$ 1.34	$ 2.00	$ 3.34	$ 2.70	$ 3.34	$ (0.64)	$ 2.27	$ 2.81	$ (0.54)
Red Oak	Turning Square	1x1x28 1/2	0.247	Anderson	0.418	0.592	$ 0.38	$ 0.44	$ 0.82	$ 0.65	$ 0.82	$ (0.17)	$ 2.63	$ 3.33	$ (0.70)
Red Maple	Panel	25/32x8 1/2x18	1.063	Valley Woodworks	0.437	2.431	$ 1.20	$ 1.95	$ 3.15	$ 2.40	$ 3.15	$ (0.75)	$ 2.26	$ 2.96	$ (0.70)
Red Oak	Part	1x3 1/4x23	0.649	Aristokraft	0.418	1.552	$ 1.01	$ 0.51	$ 1.52	$ 0.93	$ 1.52	$ (0.58)	$ 1.44	$ 2.34	$ (0.90)
Red Oak	Part	1x3 1/4x35	0.987	Aristokraft	0.418	2.362	$ 1.53	$ 0.78	$ 2.31	$ 1.42	$ 2.31	$ (0.89)	$ 1.44	$ 2.34	$ (0.90)
Red Oak	Part	1x3 1/4x29	0.818	Aristokraft	0.418	1.957	$ 1.27	$ 0.65	$ 1.92	$ 1.18	$ 1.92	$ (0.74)	$ 1.44	$ 2.35	$ (0.90)
Red Oak	Part	1x3 1/4x32	0.903	Aristokraft	0.418	2.160	$ 1.40	$ 0.72	$ 2.12	$ 1.30	$ 2.12	$ (0.82)	$ 1.44	$ 2.35	$ (0.91)
Red Oak	Part	1x3 1/4x18	0.508	Aristokraft	0.418	1.215	$ 0.79	$ 0.41	$ 1.20	$ 0.73	$ 1.20	$ (0.47)	$ 1.44	$ 2.36	$ (0.92)
Red Oak	Part	1x1 3/4x29	0.441	Aristokraft	0.418	1.054	$ 0.68	$ 0.44	$ 1.12	$ 0.63	$ 1.12	$ (0.49)	$ 1.44	$ 2.55	$ (1.11)
Red Oak	Strip Flooring	3/4x2 1/4x12	1.000	Market	0.368	2.717	$ 1.49	$ 1.92	$ 3.41	$ 2.23	$ 3.41	$ (1.18)	$ 2.23	$ 3.41	$ (1.18)
Red Maple	Part	5/16x1 7/8x17	0.111	Cardinal	0.437	0.254	$ 0.13	$ 0.56	$ 0.69	$ 0.45	$ 0.69	$ (0.24)	$ 4.05	$ 6.17	$ (2.12)
Red Oak	Turning Square	1x1x25	0.217	Moot	0.418	0.519	$ 0.34	$ 0.42	$ 0.76	$ 0.25	$ 0.76	$ (0.51)	$ 1.15	$ 3.49	$ (2.34)
Red Maple	Part	5/16x1 7/8x13	0.085	Cardinal	0.437	0.195	$ 0.10	$ 0.55	$ 0.65	$ 0.35	$ 0.65	$ (0.30)	$ 4.12	$ 7.60	$ (3.48)
Red Oak	Turning Square	1x1x13	0.113	Moot	0.418	0.270	$ 0.18	$ 0.37	$ 0.55	$ 0.13	$ 0.55	$ (0.42)	$ 1.15	$ 4.83	$ (3.68)

Table

Table 38. Unit Cost and Profitability Analysis
Ranked in Descending Order of Profitability Measure

C. Business Plans and Business Opportunities

The wood recovery project has included a search for business opportunities and a business plan to capture and exploit those opportunities. We believe that the results of the demonstration project point to some potential business opportunities for *existing* saw mills and wood manufacturers with dimension and panel production capabilities. The results of the project demonstrate that low-grade red oak and red maple pallet lumber and logs can be used to produce some value-added, potentially profitable products for identified customers in the region. The results also show that secondary wood manufacturers in the New England region have existing needs for red oak and red maple dimension parts and panels that could be profitably pursued and filled by wood manufacturing businesses in the region that have or could add dimension and panel production capability. These observations represent real business opportunities that have not been fully exploited. However, we do not believe the project results suggest that a new start-up profitable business could be fashioned out of processing low-grade materials into dimension parts and panels.

There are several reasons for concluding that demonstration project does not point to a potential new business. The most significant reason lies in the limited range of dimension parts that can be obtained from the low-grade materials. While the project did demonstrate that acceptable quality dimension pieces could be profitably manufactured from the low-grade materials, the pieces were very constrained in length and width. Most pieces produced in the demonstration project were less than 25 inches in length, and no piece was longer than 35 inches. Widths were limited to 4 inches or less, except for edge glued panels that combine several narrow strips into wider panels. Attempting to capture larger dimensions from the low-grade material drives yields way down with corresponding increases in labor and overhead cost. The orders received for the demonstration project had to be carefully screened and orders for longer and wider pieces systematically culled out and rejected. While this was acceptable for this project, it would be problematic for a commercial venture that needs to meet the exacting and varied needs of its customers.

In addition to the inherent limitations of the low-grade materials with respect to dimensions, there are quality limitations that must be acknowledged. While the “proxy customers” generally rated the pieces shipped as satisfactory or acceptable, exacting standards of defect free surfaces and color matching could be difficult or impossible to meet with exclusively low-grade sourced dimension pieces. We do not believe a shop could remain competitive and at a profitable level of capacity producing only the dimensions and quality standards obtainable from the low-grade source materials used in this project.

On the other hand, the fact that shorter dimension pieces and panels were successfully and profitably produced from low-grade materials does suggest that low-grade materials represent a viable, if not exclusive source for dimension producers. This, in turn, suggests a possible marketing opportunity for the producers of low-grade materials, the local lumber mills.

The study has documented the perceived abundance of low-grade hardwood material in the form of pallet lumber and low-grade trees within the north-central Massachusetts target area. The investigation also identified a sizable (but not quantified) potential market for dimension pieces, parts and panels manufactured from red maple and red oak lumber. That market consists of the over 300 identified secondary manufacturers of wood products located in the 6-state New England region. We were able to draw from this set of firms enough “proxy customers” to provide orders for the demonstration wood recovery project. However, due to inherent limitations in the materials related to the obtainable lengths and widths of clear wood, only a limited set of the orders generated could be filled.

Table 38, *Unit Cost and Profitability Analysis*, shows that several (16 out of 34) of the orders processed for the “proxy customers” had positive profitability measures. That table also reveals some interesting patterns and associations that will be commented on more fully below. However, the fact that *any* of the orders were “profitable” under the simulated business conditions is both somewhat surprising and somewhat hopeful.

We believe the cost figures used in the demonstration project are far more likely to overstate rather than understate the production costs of a shop set up to efficiently service and produce orders similar to those in the project. This is because the production for the project was not at optimal efficiency and the unit processing costs are computed with outside billing rates and therefore include direct processing costs, a contribution to shop overhead, and a contribution to profit.

The production efficiencies are most likely lower than what could be achieved by a producer set up to process these types of orders on an ongoing, long term basis. The subcontractor used in the study, Sargent Woodworking Company of Gardner, Massachusetts, is not optimally set up to produce the types of units making up the orders in the project. Sargent's workers, equipment, and shop procedures are normally used to produce more complex and higher quality parts and sub-assemblies. Sargent did not attempt to adjust equipment and procedures for the project orders, but rather worked them into production along with their regular production orders. Moreover, the order quantities were relatively small, causing a high ratio of set-up times to run times. David Sargent stated that his shop efficiency could have been up to 30% higher if equipment and procedures had been adjusted to fit the needs of the orders, and the orders were for larger numbers of units. Significantly greater efficiencies could be achieved by using more specialized equipment and procedures such as gang ripping and computer optimizing of rips and crosscuts. Processing a larger number of orders at one time, with the larger variety of lengths and widths in the cut list, would also contribute to improved efficiency and improved yields. We conclude that the processing costs in the demonstration project are therefore somewhat higher than what an efficient and more specialized plant could achieve, provided it could operate at or near its capacity. Such a plant could operate with readily available equipment and existing technologies. However, as mentioned above, a successful operation could not be based exclusively on processing low-grade source materials.

Examination of the individual orders in Table 38, *Unit Cost and Profitability Analysis,* reveals some interesting patterns and relationships. The most noticeable pattern is that red maple products appear to be more profitable than red oak. Table 38 lists products in descending order of profitability. The top 16 orders, and the *only* orders showing a positive profitability measure, are all red maple products. This might seem to be caused by the higher source material cost in the project. The red oak material had a unit cost of $0.65 per board foot while the red oak material (combined pallet and log) had a unit cost of just under $0.50 per board foot. However, substituting the lower ($0.50 per board foot) price into the calculations for the cost and profitability of the red oak products did not significantly change the rank ordering and did not shift any of the red oak parts into the positive profitability measure category.

The results of the demonstration project suggest that there may be more value-added and profit opportunity in processing red maple products than red oak. We also note that in soliciting orders for the demonstration project we received more interest in and orders for red maple than we had expected. Our research and "local common knowledge" had led us to believe red maple was under-value and little used by hardwood product manufacturers. Our survey of source materials identified red maple as the most prevalent, least harvested hardwood in the region. It is, therefore, especially encouraging to see this strong performance of red maple products in the demonstration project.

Counterbalancing this optimistic observation are several others. Many red maple products (7 out of 23) showed negative profitability measures, including some of the worst (Cardinal orders).

The red maple dimension part shipped to Dana Robes showed the highest positive profitability measure by a wide margin ($2.97 per board foot of material in the finished product.) This order was for a new product developed by Dana Robes specifically to make use of the opportunity provided them by the demonstration project. There was, therefore, no outside market price established for the product. We believe the "value" of this product is overstated, and would be quickly reduced by competition.

The next several products in the ranked list are all red maple panels ordered by Carrier Furniture Company for interior use in furniture manufacture. These products reveal encouraging, positive profitability measures. However, the red maple panels shipped to Valley Woodworks showed negative profitability measures. Values used for these products do reflect competitive market prices that Carrier and Valley has paid to outside suppliers. Panels require additional processing beyond that given to dimension parts, and appear to offer, therefore, greater value-added and profit potential. A business pursuing profit opportunity in producing dimension materials would be well advised to have capacity to produce panels as well as pieces and parts.

Because the methods used are likely to establish the unit costs for the orders that are higher than what an efficient producer could achieve, products that showed a positive profitability measure would almost certainly have been profitable to an efficient producer. Moreover, many of the products that showed negative measures could well have profit potential. If they are currently being produced and sold, clearly some manufactures and suppliers have found them to be viable products. However, for many of the high volume dimension products, competition from domestic and foreign sources is severe and margins are very narrow. A good case in point is the red oak strip flooring which produced a significantly negative profitability measure in the demonstration project.

Examination of the “Value” figures in Table 38 reveals a surprising degree of variability, ranging from a low of $1.15 per board foot for red oak Turning Squares for Moot Woodworking, to a high of $4.65 per board foot for red maple parts shipped to Dana Robes. To some extent, this variability in value reflects the amount of processing required. Panels and glued-up turning squares tend to show higher values than less processed parts, as would be expected. The extreme values (Dana Robe, $4.65 and Moot, $1.15) may reflect inaccurate or careless estimates rather than market values. Even so, there still seems to be a significant amount of variability in price, especially in comparison to the relative price uniformity in the grade lumber market. Grade lumber prices can vary substantially with industry market forces and conditions, but the material sells as a commodity with well-publicized and available price behavior and information.

We encountered this price variability and lack of clear and readily available price information as we researched the hardwood dimension products industry. It suggests the existence of niche marketing opportunities for small producers of dimension parts and panels. Our research has revealed a lack of well organized and targeted marketing effort by saw mills and dimension product manufacturers in the region. In fact, improved effort at marketing has been a consistent recommendation in the several industry studies sited in the bibliography.

The demonstration project has revealed some other issues of concern. One concern is the low yields achieved from the source materials. Red maple showed a yield of 43.7%. The red oak was also low with oak pallet material yield of 36.8% and the red oak milled from low grade logs, 41.8%. While not unexpected, and perhaps even better than what prior research has suggested, these low yields significantly offset the low price advantage to purchase the material. In effect it creates a multiplier of the material cost in the final product equal to the reciprocal of the yield figure. A yield of 36.8% produces a material cost multiplier of 2.7. Moreover, the low yields also generate higher processing costs per unit for the finished product due to increased defecting and cutting required to extract the clear, defect free material needed. Finally, much more waste is produced, which creates additional cost and operational problems. At some point, the cost savings from purchasing low-grade lumber are completely offset, and the manufacturer will find it more profitable to use higher-grade materials (grade lumber). Based on our research and discussion with wood product manufacturers in the region, most have opted for this course of action. However, we believe this choice has been under-examined.

Our demonstration project did not explore or answer the question of trade-off between low-grade, cheaper materials relative to use of grade lumber. This issue has been explored extensively in the research literature, but we are not aware of any studies that specifically address the use of pallet lumber as used in the demonstration project. We can only reiterate that the low-grade materials used in the demonstration project do appear to be usable in profitably manufacturing short dimension pieces, parts and panels.

The demonstration project also does not fully explore, and may even distort the business potential of producing dimension pieces, parts and panels directly from low-grade logs in a single, fully integrated, technology-aided operation. As reported elsewhere, our tours and plant visits with sawmills and wood product manufacturers included one mill in the region that has been successfully doing exactly that. The

Hull Forest Products Company of Pomfert Center, CT. (See Hull Forest Products Interview in appendix). Currently, Hull devotes about 50% of their capacity to the production of dimension products directly from selected lower-grade hardwood logs. Production is accomplished in a continuous and completely integrated series of processes that use advanced technology and are highly efficient.

The forest and wood products literature has, for many years, reported on research proposals to produce dimension products directly from low-grade logs. Much of the discussion falls under the caption of "System Six." It appears to be a persistent idea that won't go away, that looks good to researchers, but has found few successful adopters, especially in this region. Hull Forest products could be considered an exception, although they would not characterize their process as "System Six."

We regret that the present study has not been able to validate or advance the creation of a business in this region based on producing dimension products directly from the low-grade logs which are so prevalent, problematic, and under-utilized in North Central Massachusetts. It still looms as a tantalizing, but elusive answer to the problems that challenge the region and that motivated this study.

VI. Conclusions and Recommendations

A. Availability of low quality source materials.

The purpose of this project was to explore the potential for producing high valued dimension parts from under-utilized and low-valued forest products. We have examined the potential raw material supply for the purpose of determining the best available source of material for the production of dimension parts. The potential sources are logs from the forest, low-grade lumber from the sawmills, sawmill byproducts, and waste wood from used pallets and pallet parts, cut-offs from secondary wood manufacturers, and logs from shade and yard trees.

We believe that there are two source materials that best meet our objectives. These would be small and low-quality logs from the forest and low-valued lumber from the sawmill. The forest survey data we presented shows that the Massachusetts forest contains an abundance of low quality and under-utilized species and stems. Red maple in particular is available in abundance, has a relatively low dollar value, and is growing much faster than it is being harvested. Hemlock and beech are two other species that are abundant, low valued, and growing much faster than they are being harvested. There is also a large volume of northern red oak and eastern white pine in lower grade trees even though these species are higher valued and are being harvested at higher rates. In fact, there is an abundance of below grade, pallet, pulpwood and fuelwood grade stems available in all species across the board.

As discussed in Section V. of this report our findings bring into question the potential for profitably utilizing logs for this process. Kiln dried pallet lumber is available for $0.45 to $0.55 per board foot. Logs are available at a price of between $130 and $250/MBF at the mill. Milling the logs into lumber costs approximately $0.20 per foot, and drying costs $0.20 to $0.30 per foot, bringing the cost of the lumber to at least $0.53 per foot, and perhaps as much as $0.75 per foot.

More study is needed, however, before we can disregard these logs as a source of material. The literature cited includes several examples of logs being profitably utilized for dimension parts. Our study did not look at the grade yield from these logs, or the product yield as compared to the pallet lumber. There is the possibility of gaining savings if the dimension operation is part of a grade sawmill and perhaps even a firewood operation. This would allow the allocation of the logs to their highest and best use. The institution of simple grading rules for the small logs would help minimize costs and improve yields. These would be based on size, straightness, soundness, and the size and location of defects. Milling practices that are aimed at maximizing yields of dimension parts may also lead to cost savings.

Pallet lumber is also readily available in our region. Our sawmill survey revealed that close to 50% of the hardwood lumber volume produced by Massachusetts' sawmills is in the form of pallet lumber or cants. This lumber generally has a value of $200/MBF at the mill (green). The pallet lumber we viewed at several mills appeared to contain considerable amounts of clear wood. Our study produced close to 40% yields from red oak pallet lumber used for flooring. These yields could be increased if an additional sort was performed on these materials at the green chain.

In order to improve the profitability of a dimension operation it may be necessary to supplement the pallet lumber with higher-grade lumber in order to improve yields. In this regard it would again be beneficial to look at the grade yield from small logs. There is the possibility of obtaining #1 Common or better lumber from these logs, which would provide a good mixture of lumber grades.

We did conduct a demonstration of slab recovery equipment at a local sawmill; however, we feel that the recovery of products from the sawmill waste stream is an entirely separate subject. Though it is deserving of study it would have been counterproductive for us to pursue the subject while trying to accomplish our other goals. Although this material could be profitably recovered at some mills, the safety and cost issues related to acquiring the materials, the small size of the material, the limited supply, and the need for specialized equipment combined to make this course less desirable.

We did observe mills during our visit to Tennessee and Kentucky that were utilizing slabs to produce rough dimension parts. Some were even purposely creating heavy slabs at the headsaw to feed their dimension process. We do not, however, have sufficient information to judge the wisdom of this process. It is wise to strive for full utilization of the resource, and to minimize the reduction of clear wood to chips, but there is a trade-off between lumber and slab production. We have found that there is a wide variance among local mills in the production of recoverable slabs, edgings, and trimmings. In general, this is directly related to the investment the mill has made in primary recovery from the log. Mills that are sending large volumes of recoverable wood to the chipper have the option of investing either in better lumber recovery, or in recovery of products from the waste stream. Either option will require the acquisition of new equipment, the instigation of new production processes, and the retraining of employees. If they choose to attempt the recovery of products from the waste stream they will also need to research and establish new markets for the products produced.

There is a large amount of wood material available from the waste stream, and some of this material can be obtained for little or no cost. A good deal of handling would be necessary, however, to correctly sort this material, and new, and perhaps expensive, collection systems would have to be devised and implemented. Utilization of this material would also run counter to our goal of improving forest health and composition. Although there is a large potential source of material from shade tree and power line maintenance, demolition and construction debris, and used pallets, we felt that the goals of our project would best be met by focusing on forest-based sources of material. The issues of forest health and productivity are important, and will best be served by the creation of markets for logs and lumber.

Many of the other potential sources (or species) of raw material were omitted only for reasons of expediency. We needed to complete our study within a limited time period, which restricted our ability to look at a wider variety of materials. It would certainly be beneficial to look at a broader species group. White pine, hemlock, beech, and other hardwood species would all be suited to value-added manufacturing, and should be included in any future projects or studies.

We utilized two species in our project, red maple (Acer rubrum) and northern red oak (Quercus rubra). These species were chosen because of their abundance in the Massachusetts forest and because of the abundance of low quality material available within these two species. A dimension business, however, would not be limited to just these two species. The deciding factor would be the demands of the marketplace. We believe that there are potential markets for several hardwood species, and also that a strong market exists for white pine dimension parts, though this study did not look at those markets.

B. Markets for small wood products

Our research has given us a picture of a large and varied secondary wood-using industry in our region that could provide an opportunity for the establishment of a dimension part operation utilizing non-traditional materials. The majority of these companies are still producing their own component parts in-house from grade lumber, providing an opportunity for the entrepreneur who can convince some of these companies to out-source these materials. A substantial market also exists of companies already purchasing component parts. Although the species preferred by the local wood using companies are not necessarily the same ones that we have targeted, the preferred species are available locally, and an established business producing component parts may be able to improve demand for other species once the business is established.

The project did bring us a much better understanding of the market for small wooden parts. Because it is such a diverse market, one cannot enter it successfully without substantial research and preparation. We have identified the marketplace and provided the groundwork for someone interested in going further. Conversely, many of the wood users we spoke with were not aware of other options for purchasing wood. Most of them were receptive to the idea of using environmentally friendly raw materials. There is greater potential now for local wood producers to make these connections with the wood users.

We found a market that was composed of numerous companies in need of a wide variety of parts. We also found a wide variance in the price paid for similar parts. In our project some of the more profitable products were the smallest orders. It appears that it is possible to put together the right mix of customers that would provide a sufficient level of business and the necessary profits, but it will take considerable work to do so. It should be noted that we focused on the New England region, but the market for dimension parts is national, and international. Opportunities exist outside our area for those willing to venture there.

Although the literature was full of articles touting green dimensioning and the production of rough dimension lumber we found little demand for these products. Most customers want kiln dried finished panels or parts. Servicing these markets will therefore require dry kilns, molders, planers, and sanders, in addition to cut-off and rip saws.

The entrepreneur considering this market must understand that the businesses buying these parts already have companies producing for them. A new business would have to beat out these established ones, most likely on the basis of price. They would also have to be competitive in the areas of quality, quantity, and on-time delivery. These markets are foreign to the sawmiller. In addition to purchasing new equipment and instituting new practices it will also be necessary to become versed in the standards, language, and expectations of this new market.

A large number of businesses still produce their parts in-house. There is the potential of convincing them to out-source these materials, but you need to be sure that you can produce the quantity and quality required. Some companies may be willing to outsource one particular product, which may provide the avenue for establishing more business in the future.

During our study we encountered price variability and lack of clear and readily available price information as we researched the hardwood dimension products industry. It suggests the existence of niche marketing opportunities for small producers of dimension parts and panels. Our research has revealed a lack of well organized and targeted marketing effort by saw mills and dimension product manufacturers in the region. In fact, improved effort at marketing has been a consistent recommendation in several of the industry studies sited in the bibliography.

C. Developing a dimension parts business

We took low-valued materials, produced several products from them, and delivered the products to secondary manufacturers who utilized them in the production of finished wood products. We tracked our costs and estimated our potential revenues, and then evaluated the different products for profitability. Of the 34 products we manufactured, 16 were produced at a profit. Measuring potential revenues and costs on a board foot basis, our bottom line ranged from a loss of $3.68 per foot to a profit of $2.97 per foot.

This profitability measure is not an accurate measure of "true" profitability for several reasons. All of the data used in the computations are anecdotal and based on single cases or very small samples; so all inferences drawn from the analysis have no statistical validity. However, the profitability measure does provide a rational basis for ranking and evaluating the various orders in terms of "relative profit potential."

The procedures that we employed to develop these numbers must also be taken into consideration. The fact that any of the orders were "profitable" under the simulated business conditions is both somewhat surprising and somewhat hopeful. We were working with companies inexperienced with handling low-valued material, and lacking the optimum equipment to deal with this material. We paid shop rates for the work that was done. We also did not attempt to sort or grade our source materials, which could have led to higher yields. . Significantly greater efficiencies could be achieved by using more specialized equipment and procedures such as gang ripping and computer optimizing of rips and crosscuts. Processing a larger number of orders at one time, with the larger variety of lengths and widths in the cut list, would also contribute to improved efficiency and improved yields. We conclude that the processing costs in the demonstration project are therefore somewhat higher than what an efficient and more specialized plant could achieve, provided it could operate at or near its capacity. Such a plant could operate with readily available equipment and existing technologies. However, as mentioned above, a successful operation could not be based exclusively on processing low-grade source materials.

We believe that the results of the demonstration project point to some potential business opportunities for *existing* saw mills and wood manufacturers with dimension and panel production capabilities. The results of the project demonstrate that low-grade red oak and red maple pallet lumber and logs can be used to produce some value-added, potentially profitable products for identified customers in the region. The results also show that secondary wood manufacturers in the New England region have existing needs for red oak and red maple dimension parts and panels that could be profitably pursued and filled by wood manufacturing businesses in the region that have or could add dimension and panel production capability. These observations represent real business opportunities that have not been fully exploited. However, we do not believe the project results suggest that a new start-up profitable business could be fashioned out of processing low-grade materials into dimension parts and panels.

There are several reasons for concluding that demonstration project does not point to a potential new business. The most significant reason lies in the limited range of dimension parts that can be obtained from the low-grade materials. While the project did demonstrate that acceptable quality dimension pieces could be profitably manufactured from the low-grade materials, the pieces were very constrained in length and width. Most pieces produced in the demonstration project were less than 25 inches in length, and no piece was longer than 35 inches. Widths were limited to 4 inches or less, except for edge glued panels that combine several narrow strips into wider panels. Attempting to capture larger dimensions from the low-grade material drives yields way down with corresponding increases in labor and overhead cost.

In addition to the inherent limitations of the low-grade materials with respect to dimensions, there are quality limitations that must be acknowledged. While the "proxy customers" generally rated the pieces shipped as satisfactory or acceptable, exacting standards of defect free surfaces and color matching could be difficult or impossible to meet with exclusively low-grade sourced dimension pieces. We do not believe a shop could remain competitive and at a profitable level of capacity producing only the dimensions and quality standards obtainable from the low-grade source materials used in this project.

On the other hand, the fact that shorter dimension pieces and panels were successfully and profitably produced from low-grade materials does suggest that low-grade materials represent a viable, if not exclusive source for dimension producers. This, in turn, suggests a possible marketing opportunity for the producers of low-grade materials, the local lumber mills.

The results of the demonstration project suggest that there may be more value-added and profit opportunity in processing red maple products than red oak. We also note that in soliciting orders for the demonstration project we received more interest in and orders for red maple than we had expected. Counterbalancing this optimistic observation is the fact that many red maple products (7 out of 23) showed negative profitability measures, including some of the worst (Cardinal orders).

The ability to kiln dry parts rather than lumber will have a significant impact on the profitability of a dimension operation. In our study we spent a considerable amount of money to kiln dry lumber that ended up as waste or was unused. Kiln drying parts increases the amount of materials handling required, and requires new equipment and procedures, but it will reduce the overall cost of production.

The demonstration project has revealed some other opportunities. The relatively high yield of products was unexpected. Our review of the literature had led us to expect yields in the area of 33% or lower from the type of material we were using. We, however, attained yields of 43.7% and 41.8% for the red maple and red oak, respectively. Our lowest yield was 37% for the red oak strip flooring made from pallet lumber, but we believe it would be possible to raise this yield by providing the proper sized lumber. Although these yields were higher than expected, they still were low enough to, in some cases, offset the low price advantage of purchasing the material. At some point, the cost savings from purchasing low-grade lumber are completely offset by the low yields and the manufacturer will find it more profitable to use higher-grade materials (grade lumber). Based on our research and discussion with wood product manufacturers in the region, most have opted for this course of action. However, we believe this choice has been under-examined.

Our demonstration project did not explore or answer the question of trade-off between low-grade, cheaper materials relative to use of grade lumber. This issue has been explored extensively in the research literature, but we are not aware of any studies that specifically address the use of pallet lumber as used in the demonstration project. We can only reiterate that the low-grade materials used in the demonstration project do appear to be usable in profitably manufacturing short dimension pieces, parts and panels.

The demonstration project also does not fully explore, and may even distort the business potential of producing dimension pieces, parts and panels directly from low-grade logs in a single, fully integrated, technology-aided operation. As reported elsewhere, our tours and plant visits with sawmills and wood product manufacturers included one mill in the region that has been successfully doing exactly that.

We have observed that successful operations need to be either labor intensive or capital intensive. Because of the high labor and operating costs prevalent in Massachusetts the capital-intensive approach would seem to be the better choice. A vertically integrated company would be the most likely to make this work. Companies that can use the materials and by-products of their primary production would best be able to economically produce dimension parts. From a sawmill viewpoint it appears that the production of the mill would have to be in the ten million board foot per year range to justify the capital expenses of the equipment needed, and to assure the availability of the raw material needed to feed the recovery operation.

The Wood Recovery Project was a step forward in the establishment of a dimension parts business utilizing low-value wood products. Our research has provided new information on the feasibility of such an operation, but it has also highlighted the need for additional research and information gathering. We believe that we have shown that there is a substantial local market for small wooden parts and panels, but we have not proven that such a business could profitably be based on the use of low-valued material.

The potential for a business to profitably use these materials will depend upon how the business is structured. An existing sawmill could add a cut-up operation that would utilize low-grade lumber produced by the mill. Ideally this would be a mill with its own dry kiln. There are already three regional mills that have implemented these practices. A mill would be able to obtain the materials at less of a cost than an independent operation. Although these are low-valued materials, drying and transporting them will add enough to the cost to make them noncompetitive.

An existing cut-up shop, preferably one that burns its waste for heat or energy, would be in a good position to utilize this material for some of their accounts, but it would most likely have to use a mix of higher and lower-grade material. Without their own kilns they would have to either dry the lumber, which substantially raises the cost of the material, or contract with someone to dry the parts, which adds handling costs and creates the risk for product degrade during drying.

We believe that the best approach would be to site the operation adjacent to a sawmill/dry kiln. Our long-term goal is to create an integrated wood products industrial park that is powered by an on-site biomass generator. If the park included a sawmill, a cut-up shop, and some secondary wood processing facilities, each of the businesses would benefit by access to materials and offal from the adjacent businesses. They would also create substantial energy savings by using their wastes for fuel. In such a setting, with inexpensive fuels and easy access to the sawmill, a cut-up operation could profitably utilize low-valued material.